Mr Read 213 RS

LABORATORY PRACTICE

RESEARCH · CONTROL · TEACHING

VOL. 8 No. 7 Published Monthly JULY 1959

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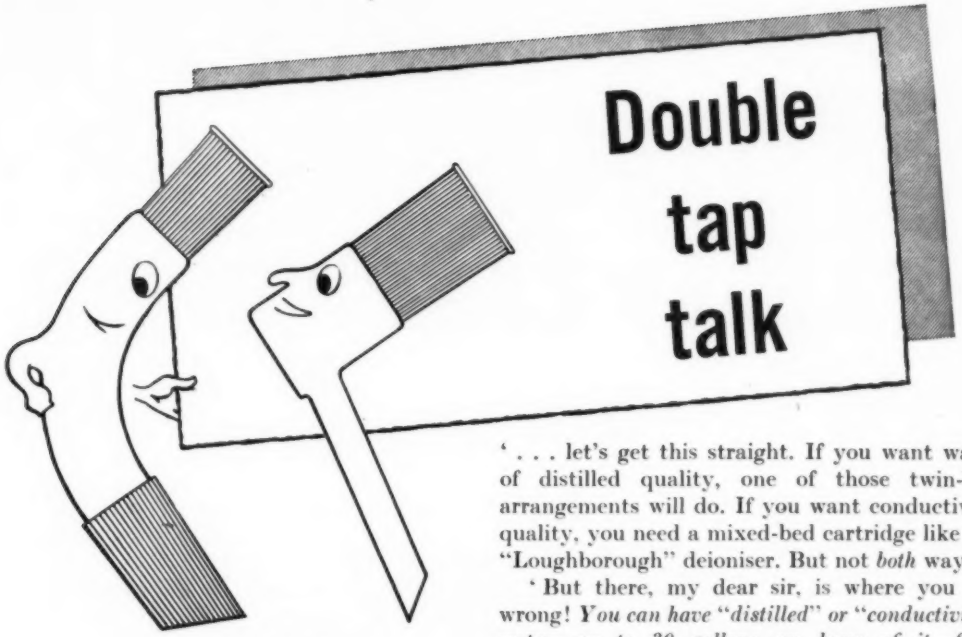

Double tap talk

'. . . let's get this straight. If you want water of distilled quality, one of those twin-bed arrangements will do. If you want conductivity quality, you need a mixed-bed cartridge like the "Loughborough" deioniser. But not *both* ways.'

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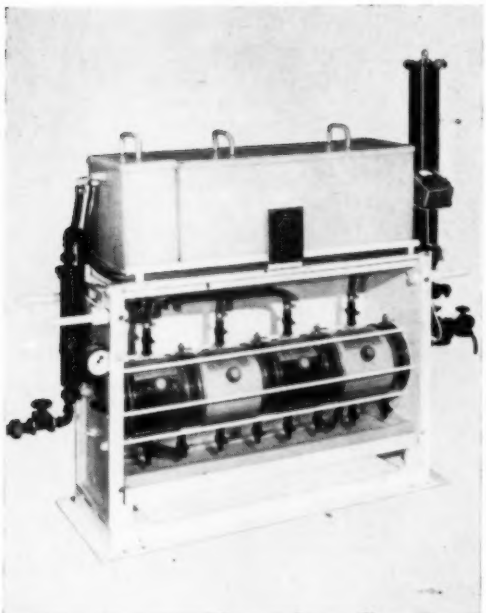
'And the cartridge . . . ?'

'Oh! That goes back to Loughborough, but since it has "distilled" water fed to it, you only need to do this every 1,000 gallons or so.'

'*300-2,000 gallons, eh?* I'm going to find out more about this.'

'Well, you only have to drop a line to . . .



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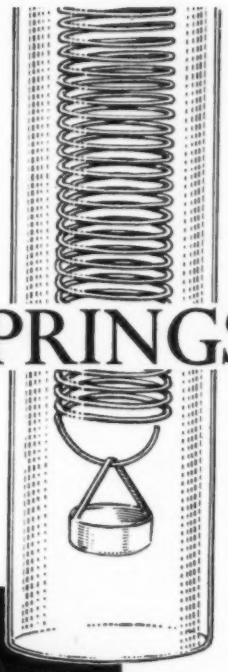

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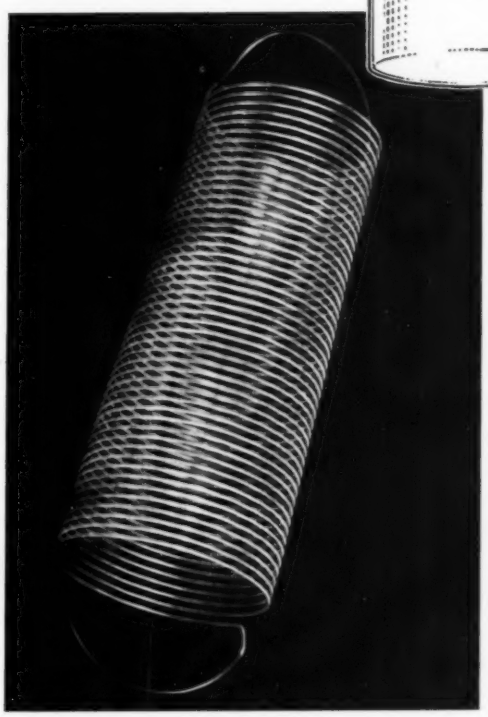
A leaflet is available giving full information.



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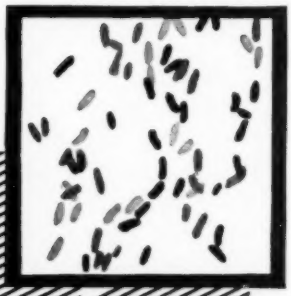
Erwinia Chrysanthemi: A plant pathogen causing Stem Rot in Chrysanthemums and Soft Rot in fleshy vegetables



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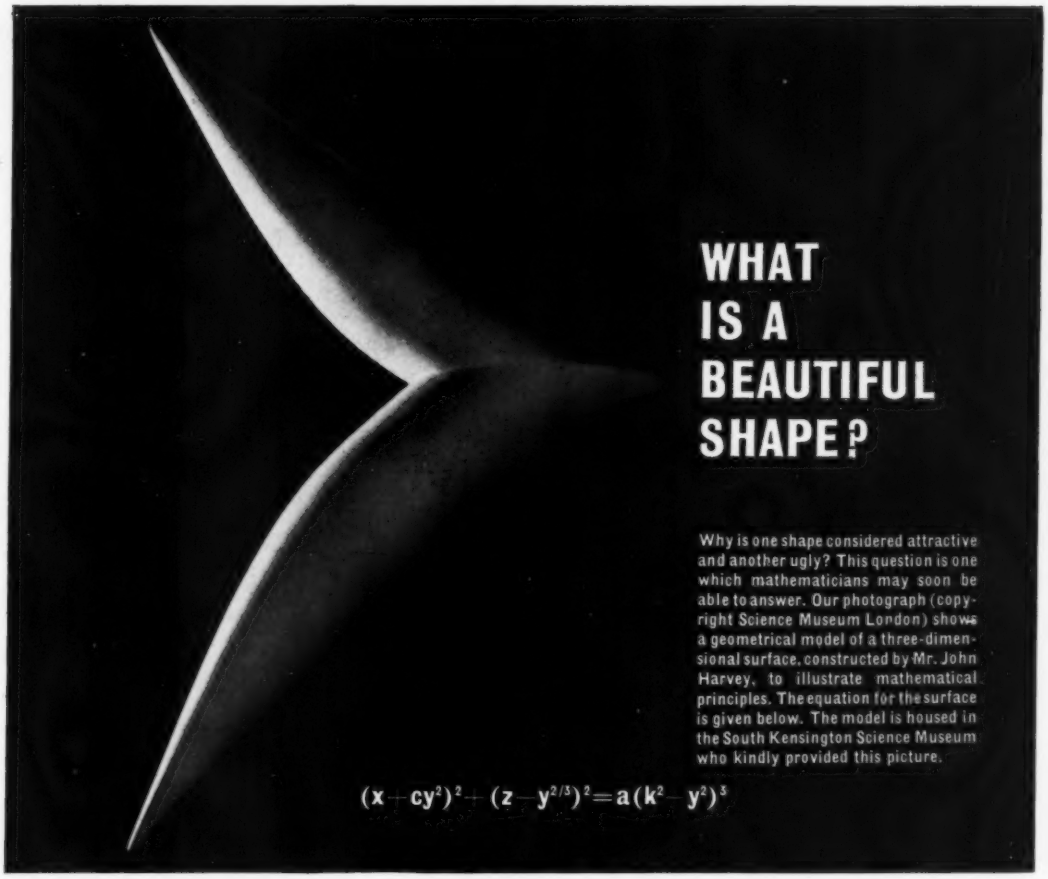

WHAT IS A BEAUTIFUL SHAPE?

Why is one shape considered attractive and another ugly? This question is one which mathematicians may soon be able to answer. Our photograph (copyright Science Museum London) shows a geometrical model of a three-dimensional surface, constructed by Mr. John Harvey, to illustrate mathematical principles. The equation for the surface is given below. The model is housed in the South Kensington Science Museum who kindly provided this picture.

$$(x - cy^2)^2 + (z - y^{2/3})^2 = a(k^2 - y^2)^3$$

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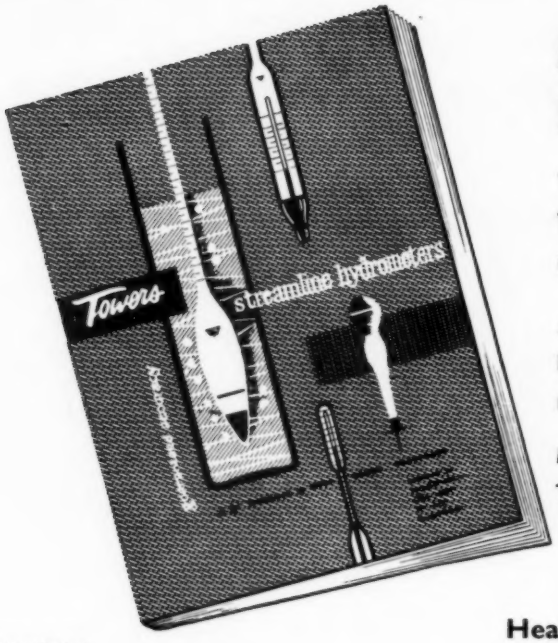

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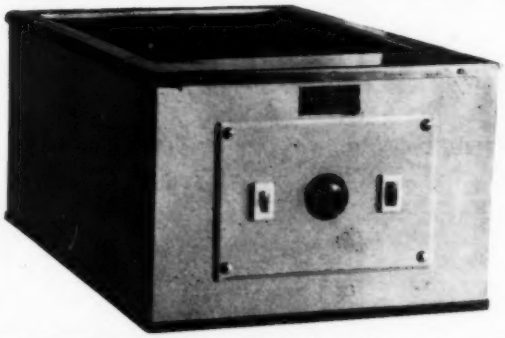

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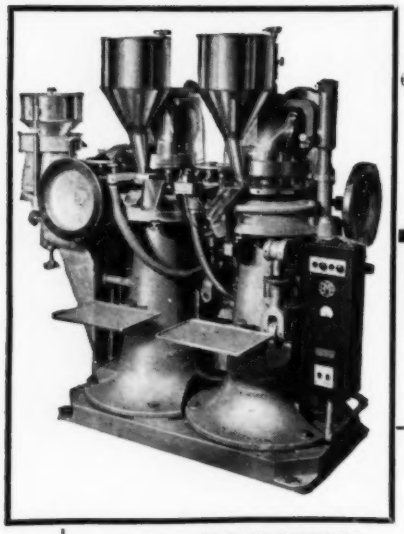

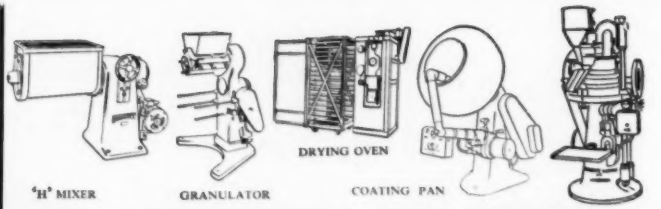

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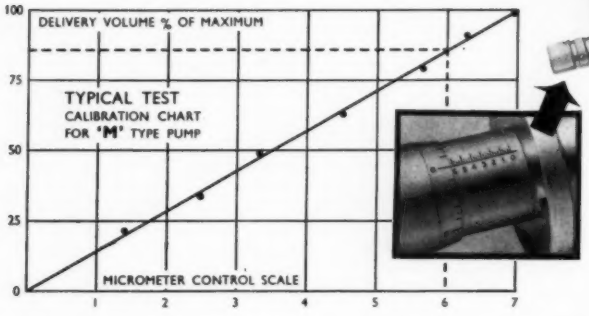

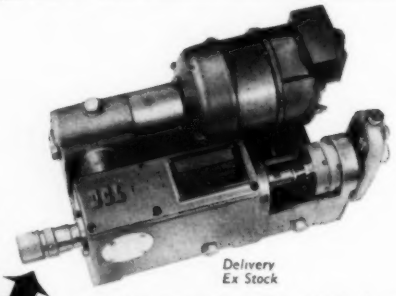

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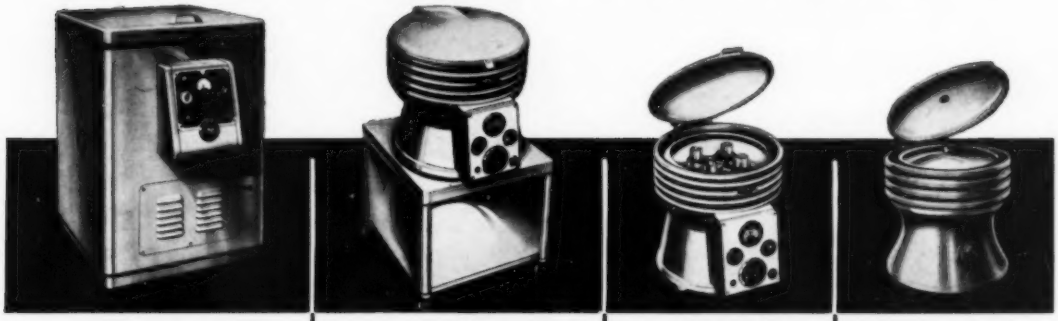

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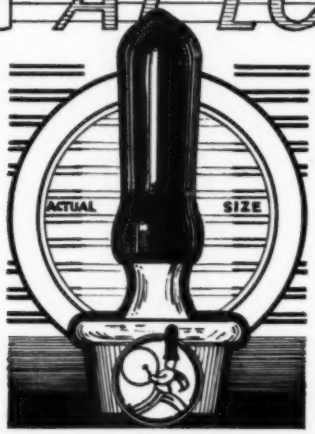

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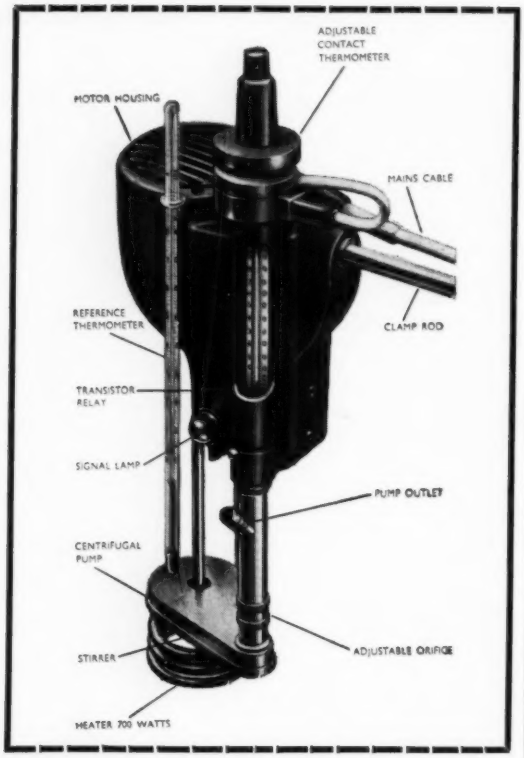

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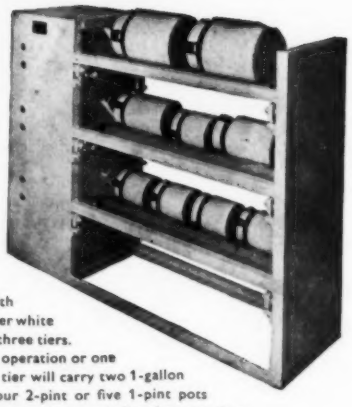

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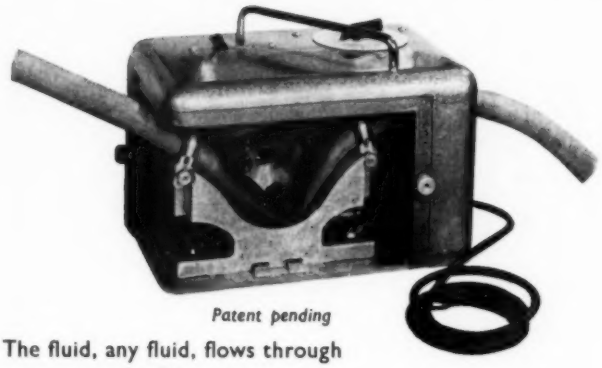

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CONTENTS

	Page
EDITORIAL	237
ARTICLES:	
THE ISOLATION AND IDENTIFICATION OF AZOTOBACTERS, *by J. R. Norris*	239
NEW DEVELOPMENTS IN THE PHYSICAL CHEMISTRY LABORATORY, Part V, *by S. Lewin*	244
THE ESTIMATION OF PHYSIOLOGICALLY ACTIVE, NATURALLY OCCURRING SUBSTANCES IN THE TISSUES AND BODY FLUIDS: ACETYLCHOLINE, L-ADRENALINE, L-*NOR*ADRENALINE, HISTAMINE, SEROTONIN AND SUBSTANCE P, Part X, *by J. J. Lewis and N. G. Waton*	248
APPARATUS AND DEVICES:	
A SIMPLE MICROMANIPULATOR, *by J. P. Heslop and J. W. Ray*	252
A SIMPLE APPARATUS FOR RAPID SEMI-MICRO FILTRATION, *by D. H. Leaback*	253
BOOK REVIEWS	254
SCIENCE AND THE FOOD INDUSTRY	255
NEWS FROM THE BRITISH ASSOCIATION OF CHEMISTS	259
LABORATORY NOTE-BOOK	260
LABORATORY EQUIPMENT AND APPLIANCES	261
NEWS	262
CATALOGUES, BROCHURES AND LEAFLETS	262

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EDITORIAL

NATIONAL PRINTING DISPUTE

Owing to the national printing dispute we are compelled to produce smaller issues and we regret that some features have been held over to enable the printers to produce the journal. We look forward to an early return to normal issues, and meanwhile crave the indulgence of our readers in a matter which is beyond our control.

The Expanding Universe

DURING the last few decades there have been revolutions in our conceptions of both the universe and the atom. To our limited minds the one appears infinitely large and the other infinitely small. We can only conceive of distances subjectively in terms of those with which we are familiar. A pilot may fly 1,000,000 miles in his career and we can visualize the distance to the most distant planet, some 3,600 M (million) miles. When we leave our planetary system the jump is staggering; the nearest star is some 24 MM miles and we see it as it was about five years ago. Looking across our galaxy or milky way we should see the other edge as it was about 100,000 years ago, long before any man-made records still extant. The nearest nebula, visible by using a small telescope, we see as it was about 900,000 years ago, and the light from the most distant started on its journey about 140 M years ago, long before life appeared on this planet. There may yet be other nebulae or galaxies beyond the range of our most powerful instruments.

These distances are really meaningless to us, and we can only attempt to appreciate them in terms of quantities that have a personal significance for us. We can appreciate the size of the earth because we can sail or fly round it, and a fair bit of it can be seen from an aeroplane at a great height. Using the earth's diameter as a unit the sun is about 10,000 units distant and the nearest star about 2,400 M units away, once

more a distance we cannot grasp. The farthest nebula is about 70,000 MM units away.

Perhaps the easiest way to attempt comparisons is to use a model. If we picture the earth as a pin's head in the middle of Piccadilly Circus the sun would be the size of a large orange about 10 yards away. The largest planet would be a small marble about 50 yards away, and the most distant an infinitesimal speck about 350 yards away. This system seems empty enough, but the nearest star would be about as far away as Rome. The milky way would extend about a quarter of the distance from the earth to the sun. The nearest nebula would be about two and a half times the distance to the sun away from us, and the farthest about 380 times the distance to the sun, or about 10 times the distance to the farthest planet away from us.

Another way of attempting to visualize these distances is to reckon in terms of the times required to traverse them in a rocket travelling at 1,000 miles an hour. We should reach the sun in about 11 years and Jupiter in about 50 years, and so could manage this in a life-time. However, it would require 400 years to reach Pluto, or about 16 generations of the human race. The nearest star could be reached in about 3 M years, and the milky way crossed in about 60,000 M years, by which time the earth would probably have ceased to exist. In 500,000 M years we could arrive at the nearest nebula and the farthest would take some 75 MM years. If we could speed our rocket to 10,000 miles an hour we should merely reduce these times to a tenth, an aspect of little significance.

So much for space travel; possibly the human race will one day concentrate its energy and money on worth-while matters. It is a sobering thought that decisions to spend money on the conquest of space are actuated largely by military requirements. All knowledge is worth while, and one can never tell to what practical uses fundamental knowledge may be put. It is really a question of priorities. While the gravest problems of human existence—food supplies, disease, housing and one might justifiably today include terrestial transport —are still with us, to the outside observer we must appear to have only a slender claim to be described as intelligent beings.

The theory of the expanding universe may be of the greatest importance in cosmic science, but it is meaningless to the ordinary individual. The only evidence appears to be that based on the Doppler effect, familiar to all of us by the change in frequency when a whistling train passes us at speed. As far as our physical measurements can tell us the radiation we recognize as light maintains a constant wavelength or frequency, and the simplest explanation of the 'reddening' effect is that the sources of the radiation are moving away from us at terrific speeds. However it is only an assumption that the laws of physics, as we know them, still hold for distances beyond our own galaxy. An alternative explanation might be that over the vast distances concerned a 'tiredness factor' operates to give the reddening effect. The greater the distance of the galaxy, the greater this reddening effect. Both theories are consistent with this observation. If the origin of the universe, as we know it, was a cosmic explosion, then this is consistent with the observation that the more distant the galaxy the faster the rate of recession. Our knowledge of the universe will always be limited by the fact that all we can do is to receive certain types of radiation, measure them and interpret the results to the best of our ability. The ultimate end of the universe is a fascinating subject for speculation. Our minds find it difficult to conceive either a beginning or an end. Will expansion continue for ever? Is space limitless? If space is curved the matter in the universe would ultimately converge with consequences resulting in the creation of another universe. Just as there may be successions of moons, planets, suns and types of stars, so may there be a succession of universes in terms of distances, times and quantities of matter and energy that are inconceivable by the human mind. It is a mixed triumph for our intellects that we have succeeded in learning so much about the universe before we have succeeded in controlling an infinitesimal speck in it.

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THE ISOLATION AND IDENTIFICATION OF AZOTOBACTERS

by J. R. Norris, B.Sc., Ph.D.

Lecturer in Bacteriology, University of Glasgow.

THE aerobic, nitrogen-fixing bacteria of the genus *Azotobacter* are widely distributed in soils and natural waters. They are characterized morphologically by their large size and by the variation in the shape of their cells and physiologically by their abundant growth under aerobic conditions in media free from combined nitrogen. Their large cells attract the attention of the bacterial cytologist and they are commended to the biochemist by their ability to fix atmospheric nitrogen and by their high metabolic rate. Q_{O_2} values as high as 4,000 have been recorded with these organisms—the highest found in any kind of living matter.

Morphology

Many published observations concern the 'pleomorphism' of azotobacter; although many of these undoubtedly owe their origin to the unsuspected presence of contaminants in the cultures studied, the fact remains that the morphology of azotobacter is remarkably variable. Rod-shaped, oval, spherical, irregularly swollen and filamentous forms are readily seen, especially in old cultures. Nevertheless, the morphology of young (12 to 24 hr.) cultures of the various species on glucose, nitrogen-free agar is sufficiently constant and characteristic to be of great taxonomic value.

Azotobacter is usually described as being Gram-negative but this is not a reliable characteristic because some strains are variable in their reaction to Gram's stain and some are frankly Gram-positive (Jensen, H. L., 1955). The cells often contain granular inclusions and in *Azotobacter chroococcum* at least a vesicular nucleus has been described (Bisset and Hale, 1953).

Some species, especially when first isolated, form refractile, double walled cells or microcysts in old cultures, that is, after incubation for about a week on solid media. The ability to form microcysts is of taxonomic value but organisms maintained by repeated subculture on glucose or mannitol agar may lose the ability to produce them. Microcyst formation is said to be favoured by growth on media containing 0·5 per cent butanol (Winogradsky, 1938).

Motility is common among azotobacter species and, despite frequent statements to the contrary, flagellation is not always peritrichous. *Az. insigne* and motile forms of *Az. macrocytogenes* have polar flagella (Derx, 1951; Jensen, H. L., 1955). Polysaccharide slimes are produced by most azotobacters and these interfere with attempts to stain the flagella. *Az. insigne*, however, produces little or no slime and the characteristic polar flagella of this species are easily stained by any of the standard methods (Fig. 7).

Growth Characteristics

Phosphorus, sulphur, potassium, calcium, magnesium, iron and molybdenum are required for growth and there are great differences in ability to utilize organic compounds as energy sources, a wide range of alcohols, organic acids and mono-, di-, tri-, and poly-saccharides being used. Acids or other organic by-products are not usually produced during growth the substrate being oxidized completely to carbon dioxide and water.

Although the azotobacters grow well on media containing only the essential ions and an organic energy source, they will grow at least as well, and often better, in the presence of some forms of combined nitrogen—as ammonium ion, for example—this being used in preference to gaseous nitrogen. Growth on meat extract or peptone broth and agar is very feeble or completely absent.

Azotobacter species are intolerant of acid reaction, and most strains grow poorly on free nitrogen below pH 6·0. Azotobacter is strongly aerobic, and fluid cultures are grown as shallow layers in the bottom of conical flasks, preferably with moderate agitation. The optimum growth temperature is 25 to 30°C.

Growth Medium

Glucose, nitrogen-free salt solution.—The following medium is suitable for the growth of almost all azotobacters: Glucose 1·0%, K_2HPO_4 0·1%, $MgSO_4 \cdot 7H_2O$ 0·02%, $CaCO_3$ 0·1%, NaCl 0·02%, $FeSO_4 \cdot 7H_2O$ 0·01%, $Na_2MoO_4 \cdot 2H_2O$ 0·0005% dissolved in distilled water. The medium may be solidified by the addition of 2 per cent agar and the glucose may be replaced by other energy sources as required. Overheating of the glucose medium should be avoided and it is usually sterilized by autoclaving at 15 lb. per sq. in. (121°C.) for not more than 10 minutes. It is probably better to sterilize the glucose separately by filtration of a concentrated solution and then add an appropriate amount to the rest of the medium which has been autoclaved at 15 lb. per sq. in. for 20 minutes.

Isolation

Several techniques are available all of which depend on the ability of azotobacter to grow in the absence of combined nitrogen and so to outgrow non-nitrogen-fixing contaminants. Each method consists of an enrichment phase followed by streaking on to glucose, or mannitol, nitrogen-free agar.

A. Isolation from Soil.—Azotobacters are found in largest numbers in fertile, well-limed soils.

1. *Direct Enrichment*

PHASE CONTRAST PHOTOMICROGRAPHS OF CELLS FROM CULTURES GROWN ON GLUCOSE, NITROGEN-FREE AGAR X 2,250.

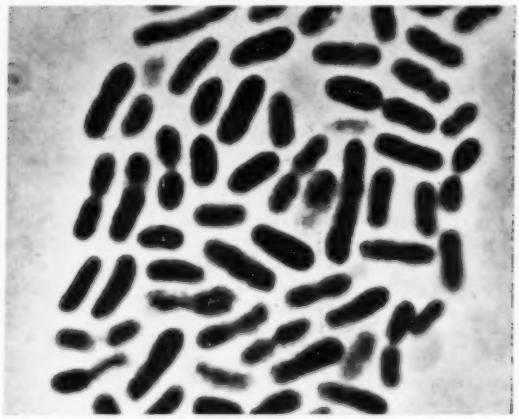

Fig. 1. 12 hour culture of *Az. chroococcum.*

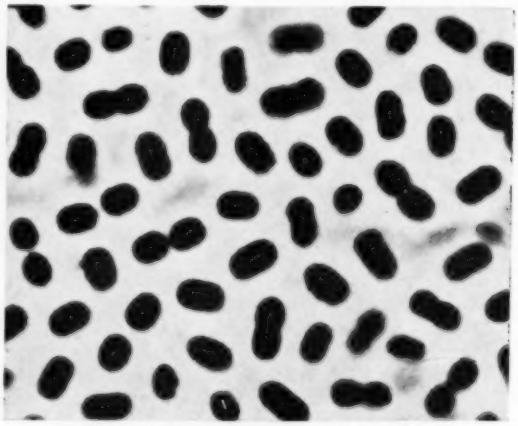

Fig. 2. 12 hour culture of *Az. beijerinckii.*

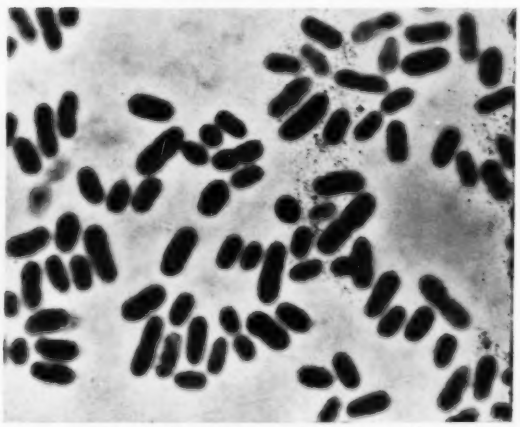

Fig. 3. 12 hour culture of *Az. vinelandii.*

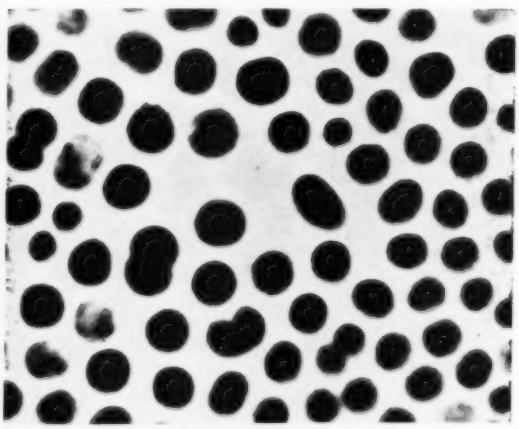

Fig. 4. 12 hour culture of *Az. agilis.*

Fig. 5. 24 hour culture of *Az. insigne.*

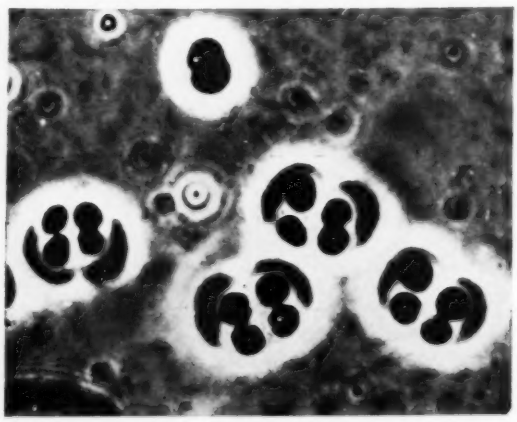

Fig. 6. 6 hour culture of *Az. macrocytogenes.* (From Jensen, H. L., 1955).

The soil sample is carefully sieved to remove stones and coarse particles and placed in a petri dish so as to half-fill it. 1 per cent (w/w) of mannitol is added and the whole mixed to a smooth paste with sterile phosphate buffer solution (0·67 g. K_2HPO_4 and 0·33 g. KH_2PO_4 in a litre of distilled water) using a sterile spatula. The surface is smoothed off with a sterile microscope slide and the dish incubated, preferably in a moist atmosphere, for up to a week at 25°C. Pearly colonies of azotobacter form on the surface and can be picked off for purification. The mannitol is not normally sterilized but for critical work it may be used as an autoclaved or sterile filtered 10 per cent solution.

2. *Silica Plate Method*
Small particles of fresh soil are placed on the surface of silica gel plates impregnated with a mannitol or glucose, nitrogen-free salt solution. The silica plates are best prepared by the method of Smith (1951), the silica 'sol' being solidified by the addition of one tenth its volume of the growth medium made up to ten times its normal concentration. Azotobacter colonies develop round the soil particles on incubation at 25°C.

3. *Fluid Enrichment*
Two g. of soil are added to 100 ml. of mannitol, nitrogen-free salt solution in a 500 ml. flask. A pellicle containing azotobacter cells develops on incubation at 25°C. for one to three weeks and the organisms may be isolated by streaking a loopful of the pellicle on to mannitol nitrogen-free agar.

The nature of the energy source may be varied in each of these methods with possible advantage as different species may be favoured under different conditions. Glucose is a suitable energy source for almost all azotobacters but mannitol has the advantage of not permitting growth of the anaerobic, nitrogen-fixing bacterium *Clostridium pasteurianum* which is very common in soils and may inhibit the growth of azotobacter during the enrichment phase of isolation. Mannitol is a suitable energy source for all the soil azotobacters.

B. Isolation from Natural Waters.—Azotobacters are most plentiful in swift flowing, well-aerated watercourses.

Although *Az. agilis* and *Az. insigne* are the only exclusively aquatic members of the genus, other species may also be isolated from watercourses and, by varying the energy source used for enrichment, it is often possible to isolate more than one species from a single water sample.

Method
25 ml. amounts of the water sample are pipetted into each of four sterile 100 ml. flasks and sterile solutions of nutrients are added to give the following final concentrations:

1. 0·02% K_2HPO_4 plus 1% mannitol.
2. 0·02% K_2HPO_4 plus 0·5% mannitol plus 1% sodium benzoate.
3. 0·02% K_2HPO_4 plus 1% ethanol.
4. 0·02% K_2HPO_4 plus 1% ethanol plus 1% sodium benzoate.

The flasks are incubated at 25°C. and loopfuls streaked on to glucose, nitrogen-free agar at intervals.

Streaking may need to be repeated several times in order to obtain pure cultures as azotobacters appear to live in close association with other organisms and may be difficult to free from them.

Fig. 7. 24 hour culture of *Az. insigne* grown on glucose, nitrogen-free agar, cells stained by Kirkpatrick's flagellum stain x 4,000.

Identification

There are six clearly distinct species in the genus *Azotobacter*. Judgment must, for the moment, be reserved with regard to a number of other organisms described in the literature many of which are probably merely varieties of the six species considered here (Jensen, H. L., 1954). Two species, *Az. agilis* and *Az. insigne* are strictly aquatic whereas the others, *Az. macrocytogenes*, *Az. chroococcum*, *Az. beijerinckii* and *Az. vinelandii* are found in soil. The last three at least can also be isolated from natural waters.

Microscopic examination of azotobacter is best carried out with the phase contrast microscope. Failing this, Loeffler's methylene blue stain gives a good picture of the shape, size and structure of the cells. Capsule and slime production are best seen in wet nigrosin preparations.

The aquatic species, *Az. agilis* and *Az. insigne*, have large oval to spherical cells 3 to 4 μ x 2·5 to 3 μ (Figs. 4 and 5). They are actively motile flagellation being peritrichous in *Az. agilis* and polar in *Az. insigne* (Figs. 7 and 8), a difference which is reflected in the type of movement of the individual cells—steady, in

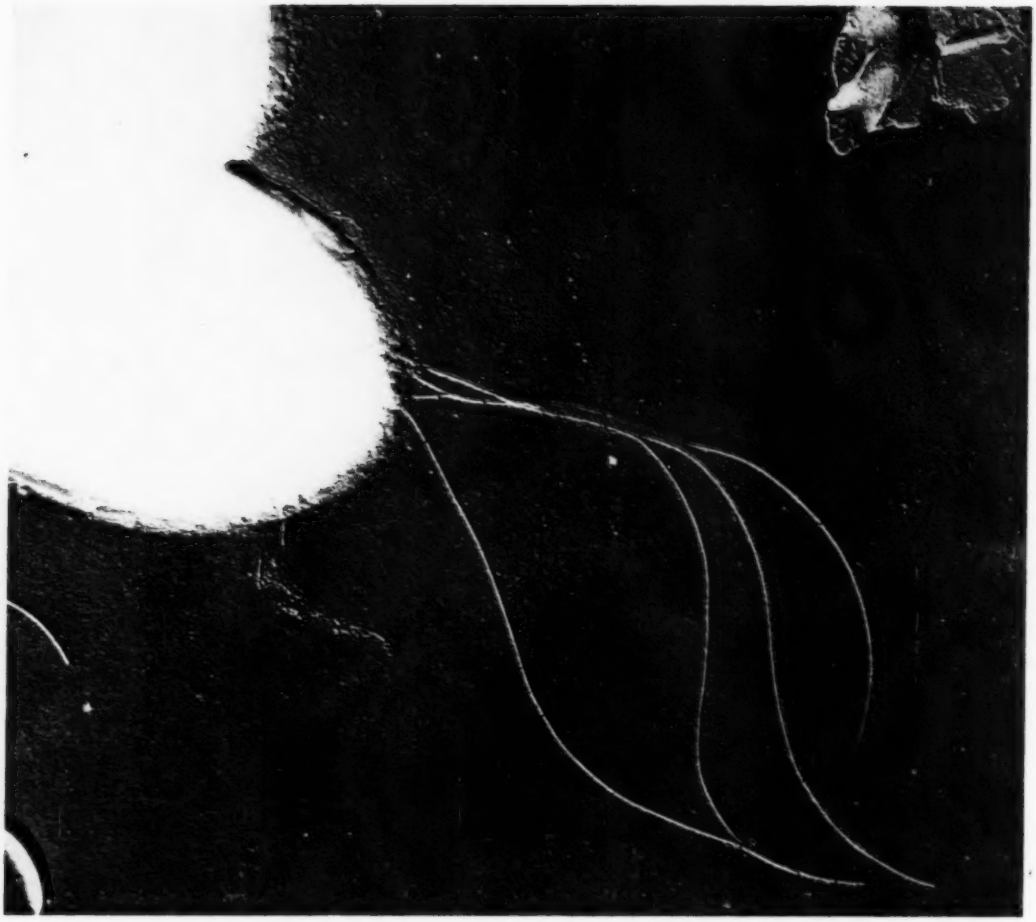

Fig. 8. Shadowed electron micrograph of *Az. insigne* x 26,250.

straight lines with *Az. agilis* and erratic circling and zig-zag movements with *Az. insigne*. *Az. agilis* grows vigorously on solid media but *Az. insigne* grows rather feebly, individual colonies rarely exceeding 1 mm. in diameter. Water-soluble pigments are produced by these two species and by *Az. vinelandii*. The colours show strain variation ranging from greenish-brown to purple. *Az. agilis* and *Az. vinelandii* produce striking water-soluble fluorescent pigments which are best seen after three or four days' incubation on glucose, nitrogen free agar. Cultures of *Az. agilis* fluoresce bluish-white under ultra-violet light and are easily distinguished from cultures of *Az. vinelandii* which have a greenish fluorescence. The cells of *Az. vinelandii* are rod-shaped and smaller than the oval cells of *Az. agilis* and *Az. insigne* (Figs. 3, 4 and 5).

Az. chroococcum and *Az. beijerinckii* produce brown pigments which are insoluble not only in water but also in most other solvents. *Az. chroococcum* produces a dark brown (sometimes almost black) pigment and *Az. beijerinckii* produces a yellow pigment darkening to cinnamon or sepia later. Some strains of *Az. beijerinckii* are virtually colourless. *Az. chroococcum* is actively motile and will grow vigorously on starch, nitrogen-free agar, characters which distinguish it from *Az. beijerinckii*. Both of these species have rod-shaped cells (Figs. 1 and 2).

Az. macrocytogenes has been isolated from only one situation, a Danish soil, and is easily distinguished from the other species. It grows on glucose, nitrogen-free agar in the form of almost spherical cells 2 μ x 2·5 μ united in clusters, often tetrads, surrounded by thick, capsule-like envelopes (Fig. 6). Very voluminous growth appears on sucrose, nitrogen-free agar and the growth will slip down the surface of a slope culture. Very large cells (up to 8 μ in diameter) are produced on 1 per cent

ethanol agar after three days. On glucose, nitrogen-free agar a characteristic, pink, water-soluble pigment is readily seen. The organism is rather unstable and several variants have been described, some actively motile by means of polar flagella. Acid is produced during growth on glucose or sucrose, nitrogen-free agar and is best demonstrated by incorporating 0·05 per cent bromocresol-purple into the medium to act as a pH indicator (Jensen, H. L., 1955).

'*Azotobacter indicum*'.—This name is applied to an aerobic, nitrogen-fixing bacterium apparently confined to tropical soils. Its cells are small (0·5 to 1·2 μ x 1·7 to 2·7 μ) and contain large polar fat inclusions. It produces large amounts of slime during growth and acid is produced on glucose, nitrogen-free agar. These and other characters serve to distinguish it from the true azotobacters and it is transferred to a separate genus, *Beijerinckia*, along with a similar organism *B. lacticogenes* (Derx, 1950: Tchan, 1953).

KEY TO SPECIES OF AZOTOBACTER
(based on that of Jensen, H.L., 1954)

Water-soluble pink pigment on glucose agar. Voluminous moist growth on sucrose agar. Acid from glucose and sucrose. Cells spherical in clusters on glucose agar, very large on ethanol agar.
Az. macrocytogenes.

Pigment brown, not water-soluble. Motile or non-motile.

Motile. Pigment dark brown. Growth on starch agar.
Az. chroococcum.

Non-motile. Pigment yellow, darkening later or absent. No growth on starch agar.
Az. beijerinckii.

Water-soluble pigments, greenish-brown to purple. Motile.

Cells rod-shaped. Microcysts formed. Green fluorescence under ultra-violet light. *Az. vinelandii.*

Cells oval to spherical. Microcysts not formed.

Strictly aquatic species.

Vigorous growth on solid media. Flagellation peritrichous. Bluish-white fluorescence under ultra-violet light. *Az. agilis.*

Colonies on solid media rarely exceed 1 mm. in diameter. Flagella in polar tufts of up to a dozen.
Az. insigne.

The author maintains a small collection of representative strains of *Azotobacter* species and would be pleased to supply or receive subcultures.

Literature

The literature up to 1954 is reviewed by Jensen, H. L. (1954). Since then *Az. insigne* has been studied by Jensen, V. (1955) and *Az. macrocytogenes* has been described by Jensen, H. L. (1955). Useful additions to our knowledge of *Az. chroococcum* and *Az. beijerinckii* have been made by Jensen and Petersen (1955).

The author is indebted to the editor of *Acta Agriculturae Scandinavica* for permission to reproduce Fig. 6 and to Mr. G. W. Ripley of the Department of Botany, University of Leeds for taking the electron micrograph.

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Laboratory Equipment in U.S. Schools

The National Science Foundation has invited teachers of science in American colleges, universities and non-profit-making organizations to submit proposals for the construction of better laboratory equipment for use in schools. Under the terms of a new, experimental programme, the Foundation will consider proposals for the design and construction of improved laboratory equipment and for the development of new instructional materials for lecture demonstrations, laboratory and field work for courses at elementary and secondary school, and undergraduate levels in mathematics, astronomy, earth sciences, physical and biological sciences, and engineering. Support will *not* be provided for the purchase of equipment for renovating school and college laboratories, or for commercial production of equipment or materials.

Fatigue of Engineering Structures

A Committee to review current research needs on the fatigue of engineering structures and to survey existing research facilities has been set up by the Council for Scientific and Industrial Research following an approach from the Institution of Civil Engineers. The Committee will not include aircraft structures, reinforced concrete structures, or metal physics in the scope of their review, though information gained in these fields will be used.

Prof. Sir Alfred Pugsley of the Department of Civil Engineering, Bristol University, has been appointed Chairman. The other members of the Committee are: Sir Donald G. Bailey, Mr. T. Baldwin, Mr. H. L. Cox, Mr. O. A. Kerensky, Mr. H. M. Pemberton, Mr. C. E. Phillips, Prof. S. C. Redshaw, Dr. P. B. Walker and Dr. R. Weck.

The Committee's terms of reference are:

'To review current research needs on fatigue of engineering structures (metal), to survey existing research facilities and to make recommendations to the Department of Scientific and Industrial Research.'

The Committee is interested in examing records of failures or accidents which might have been due to structural fatigue even if fatigue was not recognized as the initial cause. Such information may be helpful in revealing areas in which further research work is needed.

The Nutrition Society

At a recent meeting of the Nutrition Society Mr. A. L. Bacharach was elected President in succession to Dame Harriette Chick, D.B.E. Prof. R. G. Baskett, O.B.E., Mr. F. Le Gros Clark, Dr. H. N. Munro and Dr. F. Yates, F.R.S., were elected Ordinary Members of Council. Dr. R. J. L. Allen (c/o Beecham Foods Ltd., Brentford, Middlesex) is Hon. Secretary.

NEW DEVELOPMENTS IN THE PHYSICAL CHEMISTRY LABORATORY

by S. Lewin, M.Sc., Ph.D.

Physical Chemistry Laboratory, South-West Essex Technical College, London, E.17

PART V—IMPROVED TECHNIQUES IN ADSORPTION EXPERIMENTS

ADSORPTION experiments carried out by degree (or a parallel qualification) students involve the determination of the extent of adsorption by a given adsorbent from a series of solutions of increasing initial concentrations of the adsorbate, and eventual evaluation of the applicability of some relation, e.g. the Freundlich Adsorption Isotherm, or the Langmuir Adsorption Equation.

The technique usually adopted involves the preparation of the solutions, addition of a fixed volume of each solution to a fixed quantity of finely divided adsorbent, e.g. charcoal. The adsorbents, in contact with their respective adsorbate solutions, are placed in glass-stoppered bottles and then shaken manually or in a special shaker capable of holding two or four bottles, each pair of which must be balanced by weight so as not to impair the efficiency of the shaker. The shaking having been carried out—often at room temperature—for about a quarter or an hour or more, the suspension is allowed to stand so as to allow most of the particles to settle. A quantity of the liquid is either decanted carefully or pipetted on to a filter paper placed in a filter funnel. The first few filtered ml. are rejected—to avoid errors due to some initial adsorption by the filter paper—and the concentration of the solution is then determined. The quantity which was adsorbed by the adsorbent at equilibrium is now evaluated by deducting the final equilibrium concentration from the initial one. Taking as an example the adsorption of acetic acid on charcoal, the overall time required for the various processes involved, viz. standardization of the highest concentration of acetic acid, preparation of the various solutions by dilution, shaking, settling down of the suspension, filtration, and the final evaluation of the acetic acid concentration in a series of seven bottles* requires from about four to eight hours, per team of two students, depending on the speed and intelligence of the particular students; and these, as most laboratory demonstrators appreciate, may vary considerably.

Several of the steps involved have been investigated by the author with the intention of reducing the overall experimental time and also improving the technique involved:

The Process of Shaking: Shaking by hand is monotonous and wastes student time which can be usefully employed otherwise. Consequently, many laboratories employ a shaker. However, the use of a shaker often results in difficulties. The bottles have to be stoppered properly to prevent the stoppers flying off suddenly during a too rapid shaking. In an effort to secure the stoppers, students sometimes force them in too strongly, when it is very difficult to remove them. Further, students often interchange the stoppers; the result is waste of time. For these reasons it is recommended that either interchangeable ground glass reaction vessels be used or that polythene stoppers (or silicone stoppers) be used. These can be comparatively easily fitted and removed.

The use of a shaker which cannot be employed in conjunction with a thermostatic system should be discouraged where possible, because adsorption equilibria are temperature-dependent. It is not difficult to shake single reaction vessels in a thermostat, though the simultaneous shaking of several vessels requires more complicated arrangements.** It is possible to place the containing vessels in a thermostat and to stir the contents using an electrical stirrer for each vessel. However, where volatile matter is involved (e.g. the adsorption of acetic acid or iodine) a sealed stirring system is required for each vessel, the arrangement of which would add to the duration of the experiment.

A simple and convenient method, tried out and found successful by the author, is to use magnetic stirring*** e.g. use an ordinary reagent bottle of ca. 200 ml. capacity and containing the adsorbent and adsorbate solution; introduce the stirrer magnet, stopper the bottle

*It is usual to use six solutions of various initial concentrations, thus requiring six bottles. However, when the charcoal/acetic acid adsorption experiment is carried out, it is essential to carry out a blank experiment (using distilled water and charcoal) to determine the amount of free acid present in the charcoal. Experience has shown that it is outside experimental error limits.

**It is possible to suspend reaction vessels in a thermostat and to shake them periodically by hand. However, this is inconvenient and takes considerably more time because of the several operations involved, viz. removal from the bath, external drying, shaking and re-suspension. Tests on gentle shaking *in* the thermostat have shown that considerably longer periods are required to reach equilibrium, presumably owing to insufficient or non-uniform contact, between the adsorbent and adsorbate solution.

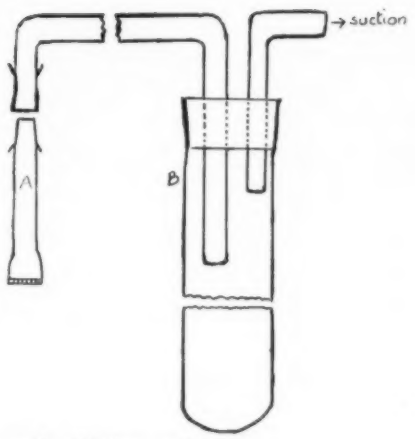
***Magnetic stirring is, in this instance, more convenient than ordinary electrical or mechanical stirring from above, because access may be easily had into the contents of the reaction vessel even during the stirring. The commercially available stirrer magnets are covered by either glass, polythene or Teflon. Experience has shown that the glass cover of the magnet tends to break only too readily. It is strongly recommended that the stirrer magnets to be used should be polythene or Teflon covered. Teflon was found to be a better cover than polythene in being more inert, e.g. polythene tends to absorb several dyes from the surrounding solution. On the other hand, Teflon when overheated gives rise to highly poisonous fumes. A given stirrer magnet can be easily encased in polythene. The method employed in this laboratory to cover magnets, the glass cover of which was broken, with polythene is as follows: Choose some polythene tubing into which the bare magnet may be gently forced. The tube should extend beyond both ends of the magnet by ca. 1/8 in. to 1/16 in. A polythene circle (cut from a suitable polythene rod or from a suitable polythene sheet with a cork borer) of approximately the same, or just slightly smaller, radius, is placed in each well. A glass rod, heated to about 110°C to 120°C, is used to soften and seal the edges of the polythene tube on to the polythene circle. The process is repeated at the other end.

and place it on top of the driver-magnet unit, when magnetic stirring may be conveniently carried out. Such an arrangement can be readily adapted for stirring at constant temperature by placing the reaction vessel not directly on top of the driver-magnet unit, but into a glass trough (containing the thermostatically controlled liquid) placed on top of the unit. It was found that, with the type of driver-magnet units available, provided the combined thickness of the reaction vessel and the thermostat did not exceed ca. 3/4 in., the magnetic stirring was sufficiently powerful. It was also found possible to use two magnetic stirring systems with a single trough, thus enabling the work to be speeded up*. The weight of the trough and its thermostatic liquid in such systems is comparatively large. It is therefore advisable to place the trough on wood blocks, sufficiently high to allow easy access to the driving magnet units, but not too high to result in considerable weakening of the magnetic attraction between the driving and stirring magnets, which effect tends to result in weakened stirring.

Filtration

Filtration through paper is usually slowed as soon as any sizeable quantity of charcoal accumulates on it. The accumulation of charcoal may be considerably reduced if the suspension is allowed to settle for a few minutes; if the suspension is allowed to stand for about an hour, it may settle completely. Instead of attempting to decant it, a required quantity may be pipetted off, thus practically eliminating any chance of disturbing the separate solid. The settling down time may however be dispensed with when filtration is carried out under a partial vacuum (e.g. using a water-pump) using a sintered glass filter. However, one has to consider the possibility that when volatile solutes are used, e.g. acetic acid-charcoal adsorption experiments, a significant reduction in the volatile fraction will result from the lowered pressures. Repeat checks by the author and a number of students have shown that, in the case of acetic acid or iodine adsorptions on charcoal, provided the application of the partial vacuum was no longer than about half a minute to a minute, the results obtained using the ordinary slow filtration and the sintered glass filtration methods agreed within the limits of experimental error involved in the volumetric titrations.

Neither ordinary filtration nor sintered glass filtration can be recommended when adsorption measurements are to be carried out at constant temperature other than that of room temperature unless *practically all* the adsorbent has been originally separated by allowing it



Upward filtration system

to settle out at the experimental temperature before the filtration. Otherwise the contact of the adsorbent with the adsorbate solution during filtration time, when the temperature tends to be different from the original temperature, is bound to lead to erroneous results. Checks carried out by the author have shown that when room temperature was ca. 20°C. and the experimental temperatures were 0°C. and 40°C. respectively, and only about half of the original quantity of adsorbent was allowed to settle out before the filtration, the duration of which was less than one minute, errors over 10 per cent were encountered.

Let us consider now the pros and cons of sintered glass filtration. When speed is essential, e.g. when the time allotted for the adsorption experiment is strictly limited, students tend to pour the adsorption mixture on to the sintered filter as soon as possible, and consequently quite an amount of adsorbent is deposited on the upper surface of the glass sinter. This deposit should, of course, be washed off with a stream of distilled water in an inverted position as soon as possible to remove practically all the loosely adhering adsorbent. A second filtration may then be carried out, and the washing out procedure is repeated subsequently. When all the scheduled filtrations have been carried out, the sintered glass can be cleaned by the usually recommended procedures.

The contamination of the sintered glass may be avoided by covering the sintered glass surface with a thin layer of paper pulp prior to filtration. The subsequent removal of the paper pulp and the deposited adsorbent layers is easily and cleanly attained by forcing a current of water in the opposite direction to that of the original filtration. The layer of pulp does, of course, tend to adsorb some of the adsorbate from the originally equilibrated solution, and precautions must be taken to guard against the possibility of error involved. These errors can be guarded against in the same way as that utilized in previously discussed filtrations, viz. by

*Timing of the rate of working of ten teams, each consisting of two students showed that the carrying out of only one reaction unit at a time (i.e. stirring or shaking of only one reaction bottle at a time) causes a bottleneck in the overall experiment, as the time required for evaluation of an equilibrium concentration of an adsorbate solution is shorter than the average time required to reach equilibrium in shaking or stirring. When two or more adsorption reactions are carried out simultaneously, the rate of evaluation of the equilibrium concentrations becomes the overall rate controlling factor.

rejecting a larger first filtration fraction. Now, when ordinary filter paper or sintered glass was used it was noted that the rejection of the first ten ml. of filtrate resulted in subsequent fractions giving uniform results. To test the required initial volume to be rejected in combined sinter and pulp filtration, several tests were carried out. Using a Grade 3 sinter of 3 cm. diameter, fine layers of paper pulp and filtering acetic acid and charcoal in various concentrations, it was found that when the solutions were filtered at a rate of approximately 100 ml. per minute, no loss in acetic acid could be noted after the first 20 ml. of filtrate were rejected.

It is possible to substitute for the above method the use of a small Seitz filter arrangement where a fresh filter paper circle can be used for each filtration, if necessary, and thereby reducing the amount of filtrate to be rejected to less than 5 ml. Alternatively, one may use a small Buchner funnel and filter paper arrangement. The last method, however, has tended to give variable results in the hands of students. This may be due to the insufficient care exercised by some in ensuring a tight fit between the paper circle and the funnel itself.

A substitute method for the downward filtration was tried and was found successful. The finally developed method was as follows:

Instead of removing the liquid from the reaction vessel by external downward filtration, *upward* partial vacuum filtration *via* a sintered funnel introduced into the vessel is employed. A straight filter unit (A) ending in a B 10 standard joint is used. The B 10 male is inserted into the B 10 female as shown; the B 10 female forming part of (B) the shown vessel where the filtrate, after rejecting the first few ml. is kept until required.

The size of the section A was so blown as to have a total volume of approximately 10 ml.

Centrifuging

The centrifugal method of separating the equilibrium solution from the solid adsorbent may be substituted for the filtration method. This required however a centrifuge capable of using centrifuge cups of ca. 100 ml. capacity*. Several trials have shown that speeds of over 1,500 rev. per minute result in complete separation of the ordinary type of activated charcoal from the equilibrium solution in less than 10 minutes. Assuming the centrifuge to possess four cup positions, it follows that about 20 minutes centrifuging is required for the seven solutions used. However, it is necessary to add to this value the time spent in the initial balancing of the cups which even with the use of a burette for the addition of water into the metal cups may require five to ten minutes per pair of cups centrifuged.

The comparative simplicity of the centrifugal method and ease of cleaning of the cups make the method an attractive one, despite the cumbersomeness of the weighings involved. However, it will be remembered that if constant temperature measurements are contemplated, then the only convenient temperature which may be used is room temperature simply because the material being centrifuged, if at a temperature different from that of ambient, will tend towards the latter; and that during the first part of the centrifuging the presence of comparatively considerable quantities of the solid adsorbent in suspension is bound to lead to different equilibria values.

One may review the results of the examination of the various possible means of separation of the adsorbent from the equilibrium adsorbate solution in terms recommending the use of the magnetic stirrer method plus the upward filtration method developed, because this type of filtration enables constant temperature determinations simply and conveniently and because such combinations have resulted in saving of time *without* the accompaniment of loss of accuracy.**

So far we have considered the purely practical aspects of the adsorption experiments. Such determinations are usually carried out using a *single* method, e.g. titrations with NaOH or thiosulphate in the respective adsorptions of acetic acid and of iodine on charcoal. Now, the teaching and utilization of individual techniques and methods is a basic need in the training of students. However, the use of a *single* technique in attacking a given problem might well be considered insufficient to meet the requirements of the development of a broader scientific outlook, because the training of students in the use of individual techniques should represent only a preliminary stage in the overall training in the scientific approach. At some later stage it is of fundamental importance to train students to compare and contrast the suitability of application of certain methods to a given problem as well as to correlate the results obtained by the use of several different tools in the elucidation of a given problem. It is essential that students appreciate that the choice, or suitability, of a certain method for tackling a given problem is often conditioned by a compromise between several requirements such as accuracy, speed of determination, monetary considerations and sometimes by what is loosely termed 'expediency'. However, the durations of the various training courses are not sufficiently long to go into every factor taken into consideration in deciding the suitability of the various techniques employed. Nor should this be done; it is essential that the student be encouraged to develop his own initiative and discrimination in assessing the suitability of a particular method to a specified problem and in integrating the requirements of contrast comparison and correlation.

It is in this connection that a number of adsorption experiments lend themselves for such exercises. For experiments lend themselves for such exercises. For

*The usual quantities of solution employed in the average student experiment is of the order of 100 ml.

**It is possible to use a downward filtration sintered glass filter having a thermojacket through which the thermostatic liquid may be circulated. Experience has however shown that the method advocated here is on the whole more rapid and more convenient. Further, thermojacketted sintered filters are more costly than the sintered types used in the upward filtration method. Incidentally, larger diameter sinters can be used as well as larger tubes and joints e.g. B14.

example, the adsorption of dichromate on charcoal can be followed by the three experimental techniques of volumetric titrations using ferrous ammonium sulphate with an external indicator or potentiometrically, or utilizing absorptiometric determinations. While time and other considerations may not make it feasible to carry many such combined operations, every effort should be made to include at least one such combined operation. Indeed, this principle should be extended further in an overall chemical integration. Too often does one find a 'closed shop' principle so far as the laboratories of different branches in the chemical field are concerned, e.g. the student is taught the use of gravimetric analysis in the determination of halide content in an inorganic laboratory, while at some other stage he is taught the use of the silver silver-halide electrode in the potentiometric halide determinations, but is not given the chance of comparing the two methods involved in the use of such combined operations when the same batch is used. The time problem is not as insoluble as might appear at first sight. Teams of two or three students may be used, provided they share preparations of the solutions and take turns in the different types of determinations. Indeed, the resulting discussions between the students themselves as to the relative importance of the various factors involved can be regarded as part of the overall scientific education and not as a case of 'the blind leading the blind'.

Recent British Standards

Analysis and Testing of Coal and Coke

In the revision of B.S. 1016:1942 the series of analytical and physical tests are now being issued in separate parts, of which the first six have already been published. Parts 7 and 11 (Ultimate Analysis of Coke, price 7s. 6d. and Forms of Sulphur in Coal, price 4s. 6d. respectively) are now available.

Part 7 deals with the determination by specified methods of the major constituents of coke, namely carbon, hydrogen, nitrogen and sulphur. The Liebig method for carbon and hydrogen has been slightly modified in detail from that given in the 1942 edition; furthermore, the use of oxygen only for combustion is now specified, particularly for a new high temperature (1,350°C.) alternative method.

The macro Kjeldahl method for nitrogen has been excluded because of the difficulty of specifying the maximum time of digestion. Instead a semi-macro method, using finely ground coke and a mercuric sulphate catalyst, has been specified.

An improved Eschka method for sulphur has been introduced, and an alternative high temperature method has been added for use when numbers of samples have to be analysed or when results are required urgently.

In general—apart from the necessary modifications—the methods follow those already specified in Part 6 for the ultimate analysis of coal.

Part 11 deals with the determination of sulphate sulphur, pyritic sulphur and organic sulphur in coal. Here the classical method of Powell and Parr specified in B.S. 1016: 1942 has been somewhat modified, digestion time for the hydrochloric acid extraction having been reduced from 40 hours to 30 minutes, and that for the nitric acid extraction from 24 hours to 30 minutes. It has been shown that an indirect calculation of pyritic sulphur content from the amount of pyritic iron present is more accurate than a direct determination.

Organic sulphur is obtained by calculation, the sum of the sulphur and pyritic sulphur being subtracted from the total sulphur determined as in B.S. 1016; Part 6.

Milk Testing

A revised edition of B.S. 734C (price 10s.) consisting of four tables mounted on two stiff boards measuring 12 in. by 11 in. and giving the percentage of non-fatty solids corresponding to given fat contents and densities of milk (fat content range 2-6 per cent.) has now been published.

The tables provide a means of relating the known fat content and density of samples of milk to the percentage of non-fatty solids present. It is important to note that they refer only to milk in which the fat content is wholly in the liquid state, i.e. where it has been pre-warmed to 40°C. and subsequently cooled to 20°C. before carrying out the density determination.

The tables form part of a full revision of B.S. 734 'Density hydrometers for use in milk' now being undertaken by a Technical Committee of the British Standards Institution.

Copies of these Standards may be obtained from the British Standards Institution, Sales Branch, 2 Park Street, London, W.1.

New Laboratories for Coil Spring Research

New laboratories for the Coil Spring Federation Research Organization at Sheffield will be among the most comprehensive of their kind in the world. They will enable research to be carried out on springs made from the finest wires to bars of up to 2 in. diameter. In addition to work on springs and torsion bars, research will be possible on materials in wire and strip form. Metallurgical research will also be undertaken on a very wide range of ferrous and non-ferrous alloys.

A major feature of the new buildings will be a comprehensive electroplating laboratory, which has been presented to the C.S.F.R.O. by W. Canning and Co. Ltd., of Birmingham.

The effect of non-metallic coatings on fatigue life is being studied. So far tensile, hardness, abrasion and corrosion tests have been devised for thin films and carried out on 13 different resin and plastic protective materials.

The research programme for this year also includes work to determine the influence of type of material, heat treatment and surface finish on the fatigue life of heavy duty springs.

Correction

In the article 'Laboratory Notes on Acetone' by S. M. Charlett and published in the February 1958 issue of *Laboratory Practice*, line 32 of page 86 should read: 'Dilute *12* ml. of acetylchloride . . .' and *not* 'Dilute 120 m. of acetylchloride . . .'

The Estimation of Physiologically Active, Naturally Occurring Substances in the Tissues and Body Fluids: Acetylcholine, L-Adrenaline, L-*nor*adrenaline, Histamine, Serotonin and Substance P.

by J. J. Lewis and N. G. Waton

Department of Materia Medica and Therapeutics, Glasgow University

PART X—SEROTONIN (continued)

Rat's Colon

As already described (Lab. Practice **6**, 450) the isolated rat's colon has been used to assay adrenaline and *nor*-adrenaline by a measurement of their inhibitory action on the acetylcholine stimulated tissue. The colon has recently been used for the assay of 5-H.T.[195–197] which also stimulates it. Interference from acetylcholine can be eliminated by the use of atropine. The procedure is as follows: The animal is killed in the usual way, and the abdomen opened. A piece of colon about 2-3 cm. long from the region next to the caecum is removed. This is easily recognizable by the striations present. The tissue is washed carefully to remove any intestinal contents, and pieces of cotton sewn through the wall at each end. The tissue is mounted in a 2 ml. organ bath containing an aerated saline solution (NaCl, 0·9 per cent; KCl, 0·04 per cent; $CaCl_2$ anhydrous, 0·003 per cent; $NaHCO_3$, 0·015 per cent; glucose, 0·1 per cent) to which atropine 1μg./l. has been added. The bath temperature is maintained at 22 to 24°C. The time cycle is 4·5 min. and the drug is allowed to be in contact with the tissue for 1·25 min. This tissue is claimed to give better results than the uterus.[195, 196].

Rat's Stomach

Recently[198] another rat tissue has been found to respond to very low concentrations of 5-H.T.; this is the fundus of the rat's stomach. Rats of either sex may be used. After removal, the stomach is put into Krebs' solution, and the fundus dissected away, leaving a small band of pyloric tissue attached, to act as a marker. The fundus is then opened by cutting along the lesser curvature and cutting to preserve the longitudinal muscle. The tissue is then cut as shown in Fig. 16. A piece of cotton is tied to each end, and the strip is gently stretched as shown, and any protrusions and fringes of pyloric tissue trimmed away to give a long, clean, thin strip of tissue.

The tissue is mounted in an organ bath, which has an internal diameter of 0·85 cm. and is 15 cm. long. The bath will hold approximately 5 ml. of bathing solution with the tissue holder and gassing tube in place. The solution is gassed with 95 per cent O_2 plus 5 per cent CO_2 or pure O_2. A rapid stream of gas is allowed to flow to ensure good stirring. With such a small bath, there is a high ratio of tissue to bathing solution, and thus if the tissue is left unattended with the bath fluid unchanged for more than 6 or 8 min. it begins to contract, probably due to the accumulation of metabolites. To prevent this the solution must be changed every 5 min. or, if it is to be left for some time, the bathing solution should be allowed to perfuse through the bath at a rate of about 1 ml./min. Slow perfusion of Krebs' solution through the bath is begun immediately after setting up the strip, so that it can be allowed to relax for 10 to 15 min. As there is no spontaneous activity in this tissue, high lever magnification can be used in recording responses and a load of about 1 g. is used to stretch the muscle between contractions.

The following time cycle is recommended. The drug is added to the bath and allowed to act for 90 sec., the bath is then washed out by overflow and an extra weight added immediately to the lever so that it comes to rest at once on a bar fixed at a predetermined level. After

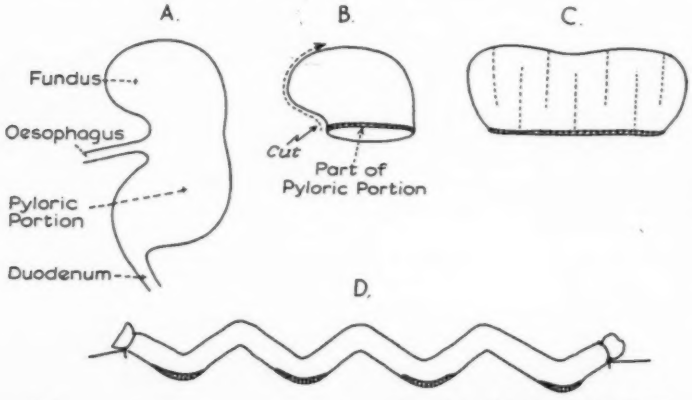


Fig. 16. Diagram showing the preparation of the fundal strip of the rat's stomach. (A) Whole stomach. (B). Fundus cut away from pyloric region, but with a small band of pyloric tissue left attached and then cut as shown round the lesser curvature. (C). The fundus opened into a plate of tissue. Cuts are then made as shown by the dotted lines. (D). The fundal strip pulled out by cotton attached to each end, pyloric tissue and pieces of extraneous tissue are then removed.

(From Vane [198] by permission of the author and the editors of the British Journal of Pharmacology and Chemotherapy.)

a constant time (15 to 30 sec. depending on the tissue) the extra weight is removed. The tissue rapidly regains its resting length and at the end of 4 min. the cycle can be repeated.

The bathing solution may be rat uterus Ringer, Krebs' solution or Tyrode's solution. In the two latter, the tissue is slightly more sensitive to 5-H.T. but there is more spontaneous movement than occurs when rat uterus Ringer is used. The tissue is always sensitive to the addition of 1 *ng.* 5-H.T. to the bath, and very often to 0·1 *ng.* 5-H.T. The use of the technique of superfusion would probably much increase the sensitivity. The chief advantage of this tissue over the rat uterus lies in the fact that the rat needs no pretreatment and rats of either sex may be used, together with its greater (10- to 100-fold) sensitivity and the fact that it will work in several different physiological bathing solutions.

The tissue is about 10 times less sensitive to acetylcholine and very much less sensitive to histamine (>500 times). If the bathing solution contains 0·1μg./ml. hyoscine, the 5-H.T. response is unaffected while the sensitivity to acetylcholine and histamine is reduced about 200 times and low concentrations of 5-H.T. can be assayed in mixtures of the three substances. Sympathomimetic amines may interfere with the assay of 5-H.T. and the method already described, for destroying these substances by using a polyphenoloxidase extracted from edible mushrooms,[193] should be applied to the tissue extracts.

Vane (personal communication) has now modified his method. Instead of using a spring lever the simpler pendulum auxotonic lever described by Paton[198a] is employed. 0·1μg./ml. of hyoscine is used to stabilize the base line and Vane recommends the use of Tyrode's solution rather than rat uterus Ringer because of the improved sensitivity.

Marine Invertebrates

Erspamer and Ghiretti[199] showed that extracts from the posterior salivary glands of *Octopus vulgaris* and *Eledone moschata*, as well as those of the hypobranchial body of *Murex trunculus* and *M. brandaris*, had a powerful excitatory action on the isolated hearts of *Helix* and *Octopus*. The substance showing the greatest effect on the isolated hearts was later shown to be enteramine (5-H.T.)[200].

Welsh, who had already used the heart of *Venus mercenaria* for the assay of acetylcholine[124], later found that it would respond, by an increase in rate and amplitude of beat, to 5-H.T.[125]. This tissue has been used for the assay of 5-H.T.[188] using a method similar to that described for acetylcholine. (Lab. Practice, **7**, 465. 1958). The heart is suspended in artificial aerated sea water at room temperature. Benzoquinonium chloride is added in a concentration of 6 μg./ml. (10^{-5}M) to the bath fluid, to eliminate any contractions due to acetylcholine. 5-H.T. increases the amplitude of beat from 10 to 50 per cent and the increase varies linearly with the logarithm of the bath concentration of 5-H.T. A 10 min. cycle must be used and the drug is left in contact with the heart for 2 min. The threshold dose for 5-H.T. varies from 0·18 to 1·8 ng./ml. The tissue is sensitive to tryptamine and N. N.-dimethyl 5-hydroxytryptamine in doses of 16 to 20 ng./ml. Tyramine and adrenaline only interfere in doses about one thousand times greater, while this tissue is insensitive to pitressin, angiotonin and histamine.

Welsh also tried several other marine invertebrate preparations and showed that *Cyprina islandica* was also very sensitive to 5-H.T. When the heart of *C. islandica* is removed and suspended in a bath of aerated sea water at room temperature, it beats with a slow regular rhythm. 5-H.T. causes an increase in amplitude and frequency when added to the bath to give concentrations between 0·1 ng. and 1 μg. per ml. This effect is completely inhibited by L.S.D. As this tissue is sensitive to acetylcholine, benzoquinonum chloride must again be added to the bath fluid (see *Venus mercenaria*). *Cyprina islandica* is readily available around the southern coasts of Britain.

Gaddum and Paasonen[201] tested the effect of various drugs on the isolated hearts of several molluscs which live in the seas around Britain, they also tested the hearts of two species of snail. They were able to show that the heart of *Spisula solida* (formerly called *Mactra solida*) was very useful for the assay of 5-H.T. because of the relative abundance of the animal and its hardiness, and due to the constancy of its heart action over long periods and its sensitivity to 5-H.T. *S. solida* may be kept in cool sea water (about 1l./animal, changed twice a week) for from two weeks to two months. Aeration of the sea water does not appear to be essential. The dissection is as follows: the bivalve is opened by cutting both abductor muscles with a thin scalpel, threads are tied near the auriculo-ventricular junctions and, because of the fragility of the auricles, a small piece of ventricle included in the ligature. The heart is suspended in aerated artificial sea water (Composition g/1; NaCl, 23; Na_2SO_4, 4·0; KCl, 0·65; $CaCl_2$ anhydrous, 1·1; $MgCl_2 6H_2O$, 10; $NaHCO_3$, 0·2:) The heart starts to beat in 5 to 60 min. at a rate 12 to 25 beats per min. 5-H.T. increases the beat when added to the bath in concentrations of 0·1 to 0·5 ng./ml. The maximal response is reached within 45 to 60 sec. and relaxation is rapid. Graded responses can be obtained within large dose limits and a maximum response requires a concentration of 1 μg./ml. 5-H.T. Tachyphylaxis does not occur. This preparation is not sensitive to other known substances in tissue extracts, except acetylcholine, the effects of which can be abolished with benzoquinonium chloride (1mg./1). The heart of *S. solida* is very hardy and will beat for several days in isolation.

The isolated heart of the freshwater mussel *Anodonta cygnea* has been used to estimate 5-H.T.[202], which causes a marked stimulation of the heart, giving graded responses in doses of 1ng./ml. to 1μg./ml. The ventricle is removed together with a short piece of intestine and suspended in a mixture of distilled water 96 parts and sea water 4 parts.

Other methods which have been used for the biological assay of 5-H.T. are:

1. *Rabbit Ear Preparation.* This method was used by Rapport, Green and Page in their work on the vasoconstrictor principle found in serum and defibrinated blood. [141, 142, 144, 145]. The method involves the severance of the ear from a freshly killed rabbit, and the cannulation of the main artery. Drugs are injected into a special cannula attached to the arterial cannula. The ear is placed upon an inclined board, which is supported in a funnel, allowing the fluid to flow from the cut ends of the veins. From the funnel, the fluid flowing from the vein is lead to an outflow recorder. The method is well described in two papers. [203, 204].

There must be no adrenaline or other sympathomimetic drug present in the assay mixture because the preparation is also very sensitive to the presence of sympathomimetic amines and can indeed be used for the assay of such drugs.

A modification of this method has been described by Grette [205], in which the pig's ear is substituted for the rabbit's ear.

2. *Sheep Carotid Artery Rings.* This method is based on an observation by Reid and Rand. [159] The carotid artery is removed and 12 rings cut from it about 8 cm. from the aorta, each about 1 mm. thick. After washing, the ring is put in a small petri dish and, using a microscope fitted with a micrometer eye piece, the internal diameter is measured, the 5-H.T. is added and the percentage change in the diameter at the major axis noted within 5 to 15 min. It is claimed that 0·025 to 1·0 μg. of 5-H.T. can be detected by this method.

3. *Chick Amnion.* [207] The amnion of the developing chick, when suspended in a saline solution, shows rhythmic contractions. It contains muscle, but no nerves. Doses as low as 20 ng./ml. increase the motility. The results are reproducable and there is no tachyphylaxis.

Other qualitative tests make use of the antidiuretic action of 5-H.T. in rats, [208] its action on the nictitating membrane of the cat [209] and several other properties described by Reid and Rand. [159].

Chemical Estimation

Udenfriend *et al.* [210] described the first good chemical method of estimating 5-H.T. Before this many chemical and physico-chemical tests had been described, but these were either non-specific or not quantitative.

The chemical method of Udenfriend *et al.* [210] involves its own method of extraction, after which the extract can be treated by three different methods for the chemical estimation of 5-H.T. The method of extraction is described here as it is specific for this method, and the extract obtained cannot be used for general assay purposes.

An aqueous tissue extract is made and 3 ml. of this taken, adjusted to pH 10 and transferred to a 60 ml. ground glass stoppered bottle containing 1 ml. borate buffer (94·2 g. boric acid are dissolved in 3 l. distilled water and then 165 ml. of 10 N NaOH added. The buffer is saturated with *n*-butanol and NaCl) by adding these substances in excess and shaking. Excess *n*-butanol is removed by aspiration and the excess sodium chloride allowed to settle. This gives a buffer of approximately pH 10. 2 g. of NaCl and 15 ml. of *n*-butanol are added and the bottle shaken for 5 min. The contents are carefully decanted into a glass stoppered centrifuge tube and then centrifuged. The aqueous layer is removed and 15 ml. of borate buffer are added to the tube and this is now shaken for 5 min. After allowing the aqueous and non-aqueous phases to separate, the aqueous layer is removed, and replaced with 15 ml. of fresh buffer solution, shaken for 5 min. and again centrifuged. A 10 ml. aliquot of the *n*-butanol layer is now transferred to a 45 ml. glass-stoppered centrifuge tube containing 20 ml. of heptane and 3 ml. of 0·5 M formate buffer pH.4*. The tube is shaken, the contents centrifuged and the supernatant layer of solvent is removed again by aspiration. The aqueous layer containing the extracted 5-H.T. is assayed by one of the three methods described below:

The distribution of 5-H.T. between the salt saturated buffer, pH 10, and *n*-butanol is such that with the volumes used only about 95 per cent of the 5-H.T. is extracted into the organic solvent. Since three equilibrations of the butanol with salt saturated buffer are employed, the final recovery of 5-H.T. is 85 per cent. Allowance can therefore be made for this in the final results.

This extraction procedure removes compounds such as tryptophan and 5-hydroxytryptophan, which are commonly used as substrates for the production of 5-H.T.

(*a*). *Assay by Ultraviolet Absorption.*

The absorption spectrum of 5-H.T. in acid solution shows a maximum at 275 mμ and a subsidiary peak at approximately 295 mμ. These peaks can be made use of for the determination of from 0·04 to 0·4 μ mole of 5-H.T. in as much as 500 mg. of tissue. The optical density is proportional to concentration to about 0·4 μ mole per ml. when measured in a 1 cm. cell in a Beckman spectrophotometer. Above this concentration 5-H.T. shows marked deviations from Beer's law.

(*b*). *Colorimetric Procedure.*

5-hydroxyindoles react with 1-nitroso-2-naphthol in the presence of dilute HCl or H_2SO_4 containing traces of nitrite to give violet coloured compounds.

To 2 ml. of the acid extract containing 0·05 to 0·8 μ mole of 5-H.T. in a glass stoppered centrifuge tube, 1 ml. of nitrosonaphthol (0·1 per cent 1-nitroso-2 naphthol in 95 per cent ethanol) and 1 ml. of acid nitrite reagent (to 5 ml. of 2N H_2SO_4 is added 0·2 ml. of 2·5 per cent $NaNO_2$. This reagent should be prepared fresh daily) are added. The tube is stoppered, shaken and placed in

*For the colorimetric procedure, 0·2M HCl is used instead of formate buffer.

a water bath at 55° for 5 min. 10 ml. of ethylene dichloride are added and the tube shaken to extract the unchanged nitrosonaphthol reagent. The tube is centrifuged at low speed, and the aqueous supernatant layer is transferred to a cuvette. When measured at 540 mμ in a Beckman spectrophotometer, optical density is proportional to concentration up to 0·8 μ mole. The colour is stable, less than 1 per cent change occurring in 1 hr. This is the method of choice when tissue extracts contain large amounts of ultraviolet absorbing material.

This colorimetric procedure can be applied to paper chromatography. After development of the chromatogram with an organic solvent and drying, the paper is sprayed with 0·1 per cent nitrosonaphthol reagent and again dried. It is then sprayed with the nitrous acid reagent (made up with HCl, not H_2SO_4.) and 5-hydroxyindoles appear as violet spots on a faint yellow background.

(*c*). *Fluorometric Procedure.*

For this procedure, a spectrophotofluorimeter which is capable of activating compounds and measuring their emitted fluorescence continuously from 250-650 mμ is necessary. Such an apparatus has been described by Bowman *et al.*[211]. It consists of a xenon arc as a continuous light source and two quartz monochromators at right angles, one to select the activation energy and one to select the emitted fluorescence. An ultraviolet-sensitive photomultiplier scanning device coupled to an oscillograph or automatic pen recorder, record the spectra which can be used both for identification and quantitative analysis.

At pH4 (the pH of the aqueous extract obtained by the above extraction procedure) maximal activation of 5-H.T. occurs at 295 mμ, coinciding with one of the peaks in its absorption spectrum. The maximum of the fluorescence spectrum occurs at 330 mμ. This procedure (which is the most sensitive of the three) has been applied to the estimation of 5-H.T. in platelets and it is claimed that as little as 0·05 μg. 5-H.T. can be measured.

Methods, which are used to measure 5-H.T. can be applied to other 5-hydroxyindole derivatives by making use of appropriate extraction procedures.

Modified Fluorimetric Procedure

The fluorimetric method already described, cannot be used for the estimation of 5-H.T. in brain because other substances present are also extracted by butanol and interfere in the fluorescence assay. However, 5-H.T. fluoresces at 550 mμ in 3N HCl[212] and this observation has made possible its identification and assay without interference from other substances.[64] The method can of course be applied to other tissues as well as to the brain.

One part of tissue is homogenized with two parts of 0·1 N HCl. An aliquot of the homogenate containing between 0·5 to 5·0 μg. 5-H.T. is transferred to a 60 ml. glass stoppered bottle and adjusted to approximately pH 10 by anhydrous sodium carbonate. Five ml. of borate buffer pH 10 (see previous procedure) are added, the mixture diluted to 15 ml. with distilled water, 5 g. of NaCl and 20 ml. of *n*-butanol added, and the mixture shaken for 15 min, after which the bottle is centrifuged and the liquid decanted from the solid material into another bottle. The aqueous layer is removed by aspiration and the *n*-butanol layer washed twice using equal volumes of borate buffer; 15 ml. of the *n*-butanol layer are then transferred to another bottle which contains 30 ml. of heptane and 3 ml. of 0·1 N HCl. After shaking and then centrifuging, the supernatant is removed and 1 ml. of the acid layer is added to 0·3 ml. conc. HCl in a quartz cuvette. The solution is activated at 295 mμ in the spectrophotofluorimeter and the fluorescence measured at 550 mμ.

The distribution of the 5-H.T. between the salt saturated buffer and *n*-butanol is such that 95 per cent of the 5-H.T. passes into the *n*-butanol. As three such extractions are made, about 15 per cent of the 5-H.T. is lost. The addition of heptane to the *n*-butanol precipitates out water which is dissolved in this phase and increases the volume of the acid phase. For these reasons, standards are made by carrying known amounts of 5-H.T. through the whole extraction procedure. By this method as little as 0·1 μg. of 5-H.T. can be detected in brain tissue, but 0·3 μg. are needed for accurate assay.

The methods described above are reliable chemical methods of estimation. Some workers have used modifications or the actual methods already described under 'Identification', involving the use of paper chromatograms. A rough quantitative estimate of the 5-H.T. present can be obtained chromatographically by using one of the dyes mentioned, to show up the 5-H.T. spot, this is then compared for intensity with several control strips containing known amounts of 5-H.T. treated in exactly the same way. Different doses of 5-H.T. are added to the baseline of each strip. A comparison can then be made directly with the unknown. An alternative method is to run a paper chromatogram of the unknown together with a control of 5-H.T. After development and drying, the control strip only is sprayed with a dye and the corresponding strip of the unknown cut off, eluted and the eluate tested colorimetrically, by ultraviolet absorption, fluorimetrically or by biological assay, using one of the methods already described.

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A SIMPLE MICROMANIPULATOR

by J. P. Heslop, M.Sc. and J. W. Ray, B.Sc.

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THERE is a need in many laboratories for simple, sturdy micromanipulators suitable for use under the medium power of a microscope. Two such instruments using pantograph movements have been described by Harding (1939) and Barer and Saunders-Singer (1951). We found in our work that the need for reduction 'gearing' with its associated tendency to backlash could be avoided by use of a suitable friction device. Bekesy (1952) has discussed in detail the principles of such devices and both he and Goldacre (1954) have described microdissectors based on friction. Unfortunately neither of these manipulators satisfied our needs. We required an instrument which would permit fine and fairly rapid movements in all three planes and allow the working point to be rotated. In addition it was necessary for us to be able to interchange tools and to use forceps as well as the more usual scalpels and needles. This paper describes a manipulator which provides the above facilities and will hold objects still while the operator attends to other things, but is simple enough to be built in the average laboratory workshop. Backlash and vibration have been eliminated. There is no need for any attachment to the microscope itself.

Fig. 1 shows a diagrammatic cross-section of the apparatus. The forceps are secured in the tool holder by a grub-screw. One end of the bracing arm is screwed to the outside of the tool holder and at the other two screws pass through the finger-grip into one limb of the forceps, holding it stationary. The finger grip retains a rubber teat which normally holds the forceps closed by its natural elasticity. The rod carrying the tool holder passes through a ball and socket joint into the grease can. The weight of the tool assembly is approximately balanced by a brass cylinder screwed to the rod, although exact balancing is unnecessary. The can is filled by pouring in soft yellow vaseline, melted in order to exclude air bubbles, and a spring circlip on the tool holder rod prevents the balance weight from breaking the surface of the grease and causing cavitation.

Experience has shown that the operations of pushing the tool against the resistance of the grease and closing the forcep points require such different amounts of muscular effort that they cannot be efficiently performed simultaneously by the hand. A separate foot operated control for the gripping action has therefore been incorporated (Fig. 2). The pipe to the suction reservoir is compressed by the force of the spring in the pedal, at the same time leaving the air leak open. By depressing the pedal the air leak is closed and the teat connected to the suction reservoir of 1 litre capacity which is partially evacuated by a bunsen pump. The teat collapses allowing the forceps to open. With a little practice, by only partially closing the air leak, it is possible to control the opening and closing of the forceps to very fine limits. The forceps can be left gripping any desired object while the operator performs some other operation.

The grease provides sufficient friction in all three planes to damp hand tremors to negligible proportions, cf. Bekesy (1952) Goldacre (1954) and to overcome gravity, holding the forceps in any position. The slight spring effect of the grease does not have any deleterious

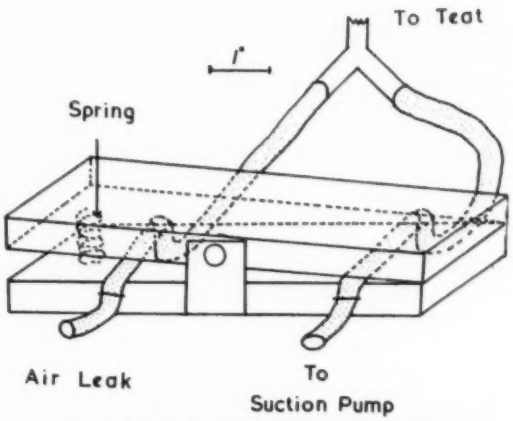

Fig. 2. The foot-pedal control for the forceps.

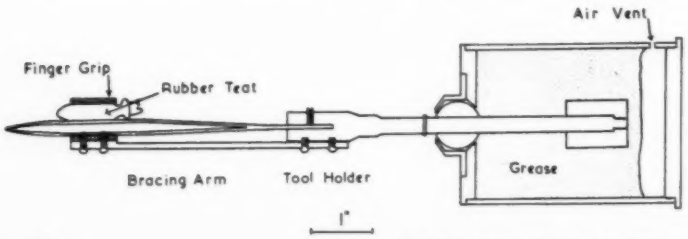

Fig. 1. Diagrammatic cross-section of micromanipulator.

effect on the operation of the instrument. Wide changes in temperature noticeably affect the resistance to movement but this can be negated by altering the length of the counterbalance rod immersed, for example, if the ambient temperature is low the increase in viscosity can be overcome by working with the counterbalance less deeply in the grease and *vice versa*. Finally the tools are readily interchangeable.

The micromanipulator was designed to enable us to desheath the abdominal nerve cord connectives of the cockroach. This involves holding a tough membranous sheath clear of the underlying nerves and tearing it without stretching or jerking the delicate fibres underneath, an operation requiring great steadiness of hand. A pair of instruments held rigidly in the clamps as seen in Fig. 3 served admirably.

ACKNOWLEDGMENTS.—*The authors are indebted to Mr. M. Cordaroy for machining all parts. This paper is published by permission of the Department of Scientific and Industrial Research.*

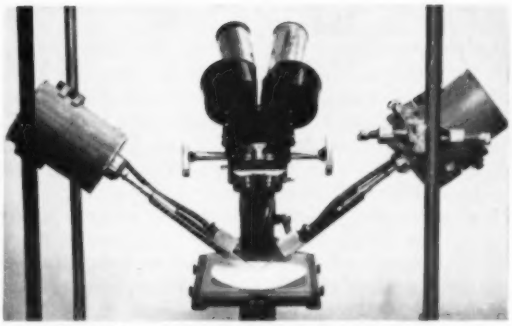

Fig. 3. Two manipulators mounted ready for use. One clamp and some bracing bars removed for clarity.

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A Simple Apparatus for Rapid Semi-Micro Filtration

by D. H. Leaback

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RAPID quantitative filtration is particularly desirable in recrystallizations of material from small volumes of solvent. Apparatus recommended for this purpose frequently employs small Hirsch funnels or ordinary glass funnels fitted with filter-plates (Chelonis 1954). With these funnels it is often difficult to bed down the filter-paper, especially if the solvent used is appreciably volatile or does not wet the paper. This difficulty can be avoided if the Hartley (1952) three piece funnel is used.*

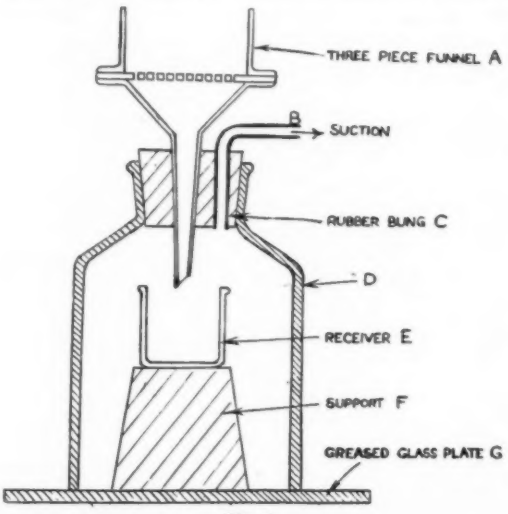

Fig. 1.

Material may be lost if crystallization takes place in receivers of unsuitable size or shape, e.g. a test-tube with side-arm (Chelonis 1954), and this has been overcome in the apparatus shown here in section (Fig. 1). Losses are minimized by collecting the filtrate in a small beaker (E) of appropriate size.

To make the body (D) of the apparatus, a wide-necked bottle of clear uncoloured glass is selected, such that (with the aid of a few supports (F)), the use of a convenient range of receivers is possible. The bottom of the bottle is cut off, and the rim ground (with carborundum and glycerol) on a piece of thick glass plate (G), until, when greased, the two components (D,G) give a vacuum-tight seal. To complete the apparatus, a suitable rubber bung (C) is bored to take a bent glass tube (B) and the funnel (A).

The apparatus is similar in principle to that described by Witt (Cummins 1950), but is simpler in construction and operation. Together with the Hartley funnel, this apparatus permits extremely rapid and efficient filtrations to be carried out.

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*Manufactured by the Royal Worcester Porcelain Co. Ltd., Worcester.

BOOK REVIEWS

Colorimetric Methods of Analysis, including Photometric Methods, Vol. IIA, by Foster Dee Snell, Ph.D., and Cornelia T. Snell, Ph.D., assisted by Chester Arthur Snell, Ph.D. London: D. Van Nostrand Co., Ltd. 1959. 112s. 6d. pp. 793 + x.

The book on colorimetric analysis now known by every analyst as 'Snell' first appeared in 1921 as a single volume. So popular was it, and such were the advances in this branch of analysis during the next two or three decades, that the third edition ran into four volumes published at intervals between 1948 and 1954. Volume II of the third edition, dealing with Inorganic Analysis only, appeared in 1949; it contains 887 pages excluding indexes. Now the authors, F. D. and C. T. Snell, joined by yet another member of the family, C. A. Snell, have produced a further 736 pages (again excluding indexes) covering advances in the same field between the date of preparation of volume II and January 1956—in fact, less than ten years. Even though the authors, by a natural extension, have included papers dealing with flame photometry and with absorption in the ultra-violet, the accelerated rate of 'progress' —or at all events, of publication of original papers— indicated by these facts is almost frightening. It suggests that another thousand pages or so will be needed in five years' time; and that ignores the necessity of bringing up-to-date the other three volumes of the third edition!

As with Volume II itself, each of the first 46 chapters of Volume IIA deals with one metal, in the order in which they occur in the usual qualitative analysis 'groups', and begins with a brief summary of the principal advances described in that chapter. This is followed by descriptions of analytical methods classified according to the nature of the material in which the element in question is to be determined, and a second part of the chapter then provides a theoretical and practical discussion of methods subdivided by reference to the reagent used or the form in which the metal is determined. The treatment is not critical; but some degree of selection has apparently been exercised and in most instances, the sensitivity of each method and possible interferences from other ions are adequately dealt with. The 'rare' metals—which have such a habit these days of suddenly becoming industrially important —are included, and a further 23 chapters follow on the determination of a number of acid radicals, oxygen and water, peroxides, and ozone.

All references are given as footnotes page by page, and—as is essential when this system is used—are accompanied by a comprehensive author index. This book does not suffer from the defect so often found in American publications that work originating outside the United States is ignored; of the 40 references given in Chapter 1 (Lead), for instance, 17 are to journals published in the U.S., 11 to those published in Great Britain, and 12 to those of other countries—probably a reasonably fair reflection of the ratio of analytical publications as a whole.

It is almost impossible to *read*, in the strict sense, a book of this kind intended for reference purposes, mainly at the bench. I have examined critically those chapters in which I am specially interested and have browsed through the rest. No serious sins of omission have disclosed themselves, and remarkably few printers' errors or other inaccuracies. I must confess that when I read the fourth sentence of Chapter 1—'A diethyldithiocarbamate method shakes the complex in chloroform with aqueous copper sulphate and reads the brown copper complex'—I was myself shaken also! I was considerably relieved to find on further perusal that the literary style of the rest of the book is in the main more orthodox. Descriptions of analytical methods are all in the imperative, and are sufficiently detailed to enable the analyst to work directly from them without reference to the original paper, though in some instances (e.g. cadmium in lead) it is necessary to possess the original Volume II of 'Snell'.

Every analyst who makes wide use of colorimetric methods—in these days this means almost every analyst —will have a copy of 'Snell' on his shelves. If the nature of his work is such that Volume II is frequently consulted, he may take it that he needs Volume IIA and that it will certainly be referred to at least as often as the parent volume. Admittedly, the price is somewhat high; but it is well bound and well printed on good quality paper and can be strongly recommended.

How soon volume IIB will appear; how many pages it will contain; what the cost will be; whether the 'Snell family' will find it necessary to co-opt another dozen co-authors to help them write it; are all matters for interesting but fruitless speculation.—ERIC C. WOOD.

Chromatographic Reviews, Vol. 1, edited by Michael Lederer. London: D. Van Nostrand Co., Ltd. 1959. 45s. pp. 276 + ix.

It is possibly safe to say that in the past ten years no other branch of chemistry has undergone such rapid strides as in the field of chromatography. Its importance may be judged by the year by year increase in the number of publications on this subject and by the diverse applications to chemical problems which had hitherto presented extreme difficulties. It is not surprising, therefore, that the organic chemist especially has used chromatography as an extremely powerful weapon in attacking the problems concerned with the separation of closely related complex organic molecules. In this connection may be mentioned the elegant and relatively simple separations effected in the spheres of steroid, terpene and alkaloid chemistry. Nevertheless, the outstanding successes achieved in the organic field must not be allowed to overshadow the equally important contributions that chromatographic techniques are making to the study of inorganic and analytical applications. Gas chromatography, for instance, in its

analytical applications has been the subject of many recent publications, where quantitative gas analysis and hydrocarbon separations have been effectively performed. The commercial apparatus now coming on to the market is a good indication of the importance of this work to industry.

Edgar and Michael Lederer are the authors of the by now classic book, 'Chromatography', and it is Michael Lederer who edits the first volume of 'Chromatographic Reviews'. The intention is to collect in book form, in English, review articles (previously published in the Journal of Chromatography and commissioned by M. Lederer) on selected chromatographic topics, written by experts in the particular field under review, and publish them annually. Of the nine papers presented in the present volume, five are concerned with organic subjects, three with chromatographic and electrophoresis techniques and one on the chromatography of inorganic phosphates. The organic chemist will find these reviews of great interest, especially that by R. Neher, 'Chromatography of Sterols, Steroids and Related Compounds' which is presented with a wealth of experimental detail in the main types of chromatographic separations, and occupies about one third of the subject matter of the book. The inorganic chemist will find much of interest in the reviews on 'Chromatography of Phosphorus Compounds', 'Separation of Isotopes', 'High Voltage Electrophoresis', and 'Chromatostrips and Chromatoplates'.

It is perhaps a pity that the reviews are of major appeal to the organic research chemist and that such topics as inorganic absorption chromatography, gas chromatography etc. are not included, whereby a more general circle of chemists would find some reviews of direct interest.

The book is well produced in clear print with excellent translations from the originals and very few errors. Illustrations are nicely set out and references are abundant. Finally, one may have no hesitation, therefore, in recommending this volume as a useful acquisition to the bookshelf of any research chemist.

G. P. MITCHELL.

Science and the Food Industry

The following is the full text of the Presidential Address delivered by Prof. A. C. Frazer, M.D., D.Sc., F.R.C.P., at the 13th Annual General Meeting of the British Food Manufacturing Industries Research Association, held on May 14, 1959.

'CALL back yesterday! Let time return!' How was the food in Britain a century ago? From numerous contemporary accounts, it would appear to have been singularly unpleasant. The poor countryman in England lived almost entirely on bread, in Ireland on potatoes, and in Scotland on oatmeal, milk and vegetable broths. Frank Buckland reported that, due to his slightly better diet, the Scottish peasant had a superior physique to his English counterpart. In the towns the poor people were little better off; the staple diet was bread and potatoes, and the edge of unsatisfied appetite was blunted by copious draughts of strong tea. The food of the rich was more abundant, but often poorly balanced and unappetizing; the availability of foods was restricted, storage facilities inadequate, and cooking was often bad.

'. . . When I think of that huge round of parboiled ox flesh, with sodden dumplings, floating in a saline, greasy mixture, surrounded by carrots looking red with disgust and turnips pale with dismay, I cannot help a sort of inward shudder . . . '.

Gross malnutrition was commonplace; tuberculosis was rife; adulteration of food was widely practised. No one knew what was wrong. If they had known, there was often no satisfactory means of detection. No one knew how to put things right. No doubt there were wonderful things in England in the 'good old days', but it was not the food.

Fortunately, at this time developments were taking place that were eventually to lead to the solution of many of these problems. The science of chemistry and development of analytical methods were taking shape. Thanks to the pioneer work of Liebig, it was gradually being realized that food consisted of chemical substances that could be identified and measured. Lawes and Gilbert were starting their revolutionary developments on the application of science to agriculture. The army of science was on the move. As it slowly gained ground against prejudice and inertia, so the necessary knowledge about the nature and composition of food steadily accumulated. Effective legislation to control the quality of food materials became possible. Many further developments followed, both in the understanding of the relationship between food and health—the science of nutrition—and in the application of this new scientific knowledge to the production and distribution of more food of better quality to the public as a whole. Thus, food industry, as we know it, can be regarded as a parallel development—and a very necessary and important one—to the development of food science. Its primary function in the community is to make the advances of food science of practical benefit to the people as a whole.

It took a long time, however, for the dreadful conditions of the first half of the nineteenth century to change and even longer for the effects of these changes on the health of the community to become apparent. Nor were these great advances made without setbacks and difficulties.

The introduction of the steel roller mill during the second half of the nineteenth century brought about a major change in the milling industry. Large scale production of bread became possible. The supply of white bread—which always seems to be in great demand—could be readily provided. It was not appreciated for some time, however, that this change in milling practice had significant effects upon the nutritional value of the flour produced. The main changes in vitamin content have, in more recent times, been corrected by fortification. Large scale production inevitably demands some level of uniformity of its products if they are to be effectively and economically handled. It, therefore, became necessary to find some easily applicable means of adjusting

the properties of flour to suit the particular uses to which it might be put. This problem was solved by the use of improving agents. These are relatively mild oxidizing agents which achieve in a very short time maturing effects in the flour that require several weeks of storage to occur naturally. Apart from saving an immense amount of storage space, chemical improvers are easily applied and adjusted, according to the differing initial properties of the grist. This useful technological advance suffered something of a setback about 30 years ago. One of the main substances used at that time, nitrogen trichloride, was shown to cause the formation of an antimetabolite, methionine sulphoximine. This was shown to cause deleterious effects in some animals, but not apparently, in man. Nevertheless, on the basis of this new scientific knowledge, nitrogen trichloride treatment of flour was discontinued. Extensive studies have been carried out on chlorine dioxide and other improving agents in use today. They cause no demonstrable change in the nutritional value of the flour, so far as human needs are concerned; they give rise to no demonstrable antimetabolites and they can be regarded as completely safe in use.

Milk supplies were unbelievably bad in the first half of the nineteenth century. Cows were kept under filthy conditions and the milk would not keep long enough for more than local distribution. Great improvements occurred during the second half of the century. Legislation was introduced controlling dairy conditions and the development of the railways provided better transport facilities. However, the wider distribution of milk also brought troubles with it; wider dissemination of milk-borne diseases. Pasteurization and other measures eventually brought this problem under control, but not until many years had passed. Another development in this field that has been steadily gaining ground for over a century is the manufacture of condensed, evaporated and dried milks, which has now reached a high level of efficiency.

So with most other foods. In the middle of the nineteenth century butter was commonly rancid and uneatable; meat was often decomposing and sold in filthy markets; fish was worse; even drinkable water was not readily obtainable in London at the time of the Great Exhibition in 1851. New and improved methods of food preservation and transport were, however, on the way. Methods of drying foods were being used experimentally—the description of many of the early products makes unpalatable reading. Dried soups came on the market and were quite successful. The use of chemical preservatives began to develop with the realization of the importance of bacterial spoilage at the end of the century. The introduction of chemical preservatives raised questions of toxicity; many problems in this field are still with us today and require careful study. Canning was introduced at the beginning of the nineteenth century, but many of the early products, largely used by the Navy and other services, were far from attractive. Immense improvements in this field have occurred during the last 50 years. Many other developments, such as the use of fats to make margarine, and the introduction of refrigerated storage and transport, have made their contribution to the complete revolution in our food supplies which has come about in the last hundred years.

What an incredible change there has been! From the restricted range of poor quality food of a hundred years ago to the vast choice of first-class food materials readily available in every village shop today. There is no difficulty nowadays in getting safe water, fresh milk, butter, fruit, vegetables, meat and fish, and at a price level which is within the means of a great majority. What about the effect of all these changes

In the centre Lord Cohen of Birkenhead, President of the Royal Society of Health and chief guest of the B.F.M.I.R.A. talks to the chairman of Council, Mr. C. O. Barber, during the reception. The President of the Association, Prof. A. C. Frazer of Birmingham University and shown on the right, listens to the conversation.

on the health of the people? As I have said, some of the changes and developments gave rise to new problems; some time had to pass before the improved availability of foods reached an economic level that could result in betterment of the health of the community as a whole. In 1900 the physical condition of the mass of people in this country was at a low ebb. Rowntree's description of conditions in York shocked all thinking people. The poor level of the general health of the mass of the people in England was fully appreciated for the first time. Since then, the progress in food science and food industry, together with a generally better standard of living, has resulted in steady improvement in nutritional state. The final effects are only now becoming clearly apparent. Malnutrition is uncommon, except in people with some underlying disease, or in neglected children or old people. Tuberculosis is much less common and the physique of school children has noticeably improved. I saw recently some school desks that had to be discarded because they were not big enough for the children of today. The effect on health of improved food supplies and their better distribution is apparent to everyone, but there are no grounds for assuming that improvement is yet complete. What we now see is just the beginning.

Of course, many factors have been concerned in the great improvement in the standards of living in this country that have occurred during the last hundred years. But this story of the improvement in food supplies and nutritional standards which I have told is the story of your industry, of which, in my opinion, you have every reason to be proud. The food industry has paid a vital part in the implementation of advances in scientific knowledge and in the raising of the standards of food available to the community as a whole. There are, however, many more problems to be solved; new discoveries to be made; new knowledge to be applied for the betterment of the community, its food and its health. The food industry should press on with the work that it has done so successfully over the last hundred years. Let us have even more food, let the quality be enhanced even further, let the prices be reduced so that wider availability still is possible. Even when everything is perfect here, and that is a long way off, let us not forget that at the present time more than half of the world's population are worse off than the English peasants of the early nineteenth century. Is it so inconceivable that what has happened in England over the last hundred years might not be repeated on a much wider scale in other parts of the world? I think not. To my mind it is a worthy

challenge to all concerned with food—to work for the banishment of hunger and malnutrition from the face of the earth.

One might imagine that all concerned with an industry whose development and progress has been so clearly dependent upon the results of scientific research would be firm supporters of research in all its forms. Strange to say, this is not the case. There are many people in the food industry who do not consider that scientific research is essential to the industry, who do not give it full encouragement and support, and who would like to apply severe restrictions to the type of research financed and sponsored by the food industry. It seems to me to be a matter of some importance to attempt to understand the point of view of these people and to see whether something might be done to get over some of their apparent difficulties.

Perhaps we should first be clear what we mean by the word research. All scientific work cannot be included under the term 'research'. Thus, control work in industrial laboratories cannot, as a rule, be classified in this way. I think it is wise to insist that research must involve some attempt to add to new knowledge. The work involved in control studies may be of vital importance, but it may not involve any new observation; there may be no attempt to add to the store of knowledge; it is done as a routine check on materials, methods, or products. The first objection that may be made to research is that it is high-falutin' theoretical stuff not closely enough related to everyday problems of the industry.

To understand this problem we must give a few minutes' thought to the old question of fundamental *versus* applied research. A great deal of nonsense is often talked about this subject. There are, however, two extremes that can be considered. The difference between them is essentially one of objective and development. Fundamental work is done with the primary objective of adding to the store of new knowledge; as one question is answered, so one or more further questions emerge; the work is planned to find the answers to these questions *seriatim*, so that gradually a new structure of knowledge is built up. Such work has no limitations other than those of time, the facilities available and the capability of the investigators. From the financial point of view it is to be regarded as a continuing expense. Given any particular field, there is no likelihood of everything there is to know about it being discovered within a measureable period of time. Applied work, on the other hand, is undertaken to answer a specific enquiry; when the answer to this question is obtained, it is quite probable that the investigation will be regarded as closed and the work will stop. Such studies may, of course, add to new knowledge, but only in a limited way. Such undertakings are much more clearly defined and their cost can usually be estimated with fair accuracy. Applied research is commonly regarded as a time limited commitment.

It is obvious what the reaction of many administrators and those responsible for making budgetary estimates must be to these two forms of research. Applied research is predictable, controllable and has an obvious objective that is plain to everyone; there is no difficulty in deciding whether it was worth while or not. Fundamental research, on the other hand, has a terrifying vagueness about it; it is impossible to predict exactly what may be wanted in the course of development; it is a continuing expense and it may be extremely difficult, or even impossible, to estimate its true value. Who put much value on Fleming's work on penicillin in the 1930s? No one. It was an academic, high-falutin' research observation! Yet it saved millions of lives in the 1940s and changed the face of medicine.

Whilst I am sure we should not go around trying to put 'fundamental' or 'applied' labels on to people's work, it is important to realise that these different objectives and forms of development do exist, since they call for quite different types of administrative handling. In the case of applied research problems, the nature of the enquiry can, indeed should, be decided in advance. The problem is then put to a scientist, or group of scientists, who devise the ways and means for obtaining the answer and carry out the work. This sort of procedure appeals to a certain type of scientist who may well be in the top flight technologically. If, however, fundamental work in a particular field is required, there is only one way to get this done effectively. Find a person who is keen and competent to do the work. Having found him, create the situation in which his work can flourish, and then continue to back him as hard as you possibly can. If your choice was right, the result will be brilliantly successful; if it was wrong, it is likely to be an unfruitful enterprise. The mistake is often made of thinking that we always have to deal with one extreme or the other. This is not so; there is every conceivable gradation between these two extremes.

So far as the food industry is concerned, your Research Association provides an excellent example of a carefully adjusted balance between fundamental and applied research. They carry much of the work they undertake to as fundamental a level as possible, since this is likely to benefit science and the industry as a whole. They also carry out more applied studies which are of particular value and interest to one section of the industry. Industrial firms themselves frequently carry out more applied studies still, which may be designed to provide new information only of major interest to that particular concern. In general, I think it is fair to say that laboratories within industrial concerns, with the exception of the very large organizations, tend to carry out work that is very much at the applied end of the research spectrum, while Universities and Research Institutes should be the major centres for fundamental research. Your Research Association is the vitally important link that should be in a position to encourage and promote fundamental work in particular fields in Universities or Research Institutes through extra-mural grants and should make this an active liaison by pursuing similar fundamental studies within their own laboratories. At the same time, through their applied research studies and information services, they must maintain the closest link with industry, so that they keep in touch with current thought and needs, and bring the latest scientific developments into practical use as quickly as possible. Your Research Association, as you know, does this; I think it is true to say, however, that it could do it more effectively and more extensively with great advantage to the industry if it received wider encouragement and support.

Of course, I would not deny for a moment that I am biased in favour of fundamental research. I make no apologies for that. I have heard it argued that the advances in science have been so great during the last 50 years that there is no need to bother with any more fundamental work; all we need to do now is to concentrate on applying our present knowledge. This will keep us busy for a long time. What a dangerous idea this is and how unwise! It is, I believe, founded on a false premise. Thus, every indication in the many problems facing the food industry at the present time is that there is a serious lack of fundamental knowledge. The amount of basic research being done is not too much, or even sufficient—it is too little! Even if there was a great plethora of knowledge, it would still be unwise to call a halt. The number of major contributions to new knowledge is not so great that we can

afford intentionally to reduce their number. People with original ideas who are able to establish new facts are not so numerous that one can knowingly afford to discourage one of them. New ideas leading by research to new facts; this is the very lifeblood of applied research. The science must be there before you can apply it. If you cut off the supply, all that applied science can do is to continue to elaborate on the existing themes. This has its uses, but it is not progressive. In my view, no industry, least of all an active and competitive one like the food industry, can afford to be non-progressive, even for a short time. I can see how this idea of concentrating on application appeals to some people. I must say, however, in the most emphatic terms, that I am sure that the implementation of any such policy would be disastrous. The food industry should support fundamental work more than it does at the present time and to the limit of its ability; this way progress lies. The more applied aspects will never be in danger and can safely be left to look after themselves.

But, you may say, why should the food industry be expected to foot the bill? If this is all so important for the community, why shouldn't the Government pay? What a splendid idea—or is it? First of all I must say that I consider that the food industry has a real responsibility to the community. In some industries, perhaps, making money is the only serious consideration. While this, of course, is an important matter in the food industry, too—and, indeed, it is a necessary condition of survival—there are other aspects that are, to my mind, of equal importance. It is the privilege of the food industry to provide and distribute a large proportion of the nation's food. This food is fundamental to the health, welfare and happiness of every man, woman and child in the country. The industry will play a vital part, as it has done in the past, in trying to get as much as possible of the best quality food available at economic prices to every section of the community. Very well, if the food industry have all this responsibility, should they also have to foot the bill? Let us consider for a moment who does pay for research. The money that any individual firm pays towards a centralized research fund is, of course, in the long run paid by the consumer. There is, presumably, a fractional increase in price on the commodities produced. In my view, this is not unreasonable, since research supported and financed by the food industry, if properly organized, should ultimately benefit the consumer. If every firm in the food industry made a reasonable contribution to centralized food research, the increase in cost of food to the consumer would be immeasurably small and the amount of money available for research much greater than it is today. Altogether too many people in the food industry think of science only in terms of control work or applied research; if they give their money to centralized research, they want to see a return in the form of answers to specific questions. I am entirely in favour of an effective information system and the provision of answers to worrying and urgent problems; all that I ask is that this should not be done at the expense of research of wider interest and greater potential value. Why should not the Government pay? In the first place, this merely means that everyone pays instead of those people who consume the products of the food industry. Since, apart from the consumer, it is the food industry that stands to gain in every way from food research, it seems reasonable that they should meet at least a substantial part of the cost. If this is too heavy a burden to be economically absorbed within the ordinary limits of trade, then some Government subsidy may seem reasonable. In practice, of course, this happens, since all contributions from industry to the Research Association are matched by funds from general Government sources. It is difficult to conceive a more equitable system than that set up by the Department of Scientific and Industrial Research in their organization of Research Associations.

Finally, what can be done to improve the liaison between science and the food industry? There is, of course, considerable contact through the medium of scientific societies, and I would be the last to suggest that we should add any unnecessary meetings to the present formidable list. Nevertheless, I think there is a need for further opportunities for a frank exchange of views between scientists working in the food science field including its medical aspects, and those engaged in the food industry. Meetings organized to bring together all the groups involved and to provide an opportunity for free discussion of selected current problems might go a long way towards bringing about a better appreciation of the real problems involved. It is possible that the Research Association might play an important part in the organization of such meetings, since it is the obvious link between the various sciences and the industry. There are, however, many ways in which meetings of this sort could be handled. The only point that I should wish to put before you today is the thought that a closer association might be established between scientists working in fields of interest to the food industry and those who are actively engaged in the technological and productive work of the industry. If the outcome of such meetings was only a greater awareness of problems of mutual interest and current lines of thought, this would be worth while. In spite of all the conferences, congresses and meetings, of which there are now an embarrassingly large number, there still seems to be a need for planned symposia, or some other form of organization that intentionally brings together particular groups of people, with a view to fostering a better understanding of common problems.

Each year I have the privilege of addressing my remarks to you, who, if I may say so, are those representatives of the food industry who obviously need no encouragement from me, since you are already members and supporters of this Research Association. I trust that you will forgive my 'preaching to the converted' in this way, for, as I am sure you will appreciate, my remarks are directed through you and beyond you at many members of the food industry who, in my view, do not give adequate support to food research.

To summarize the points I have put before you: first, I can recommend a little historical research into the development of Britain's food supplies over the last hundred years to anyone who does not appreciate the immense progress that has been made during this period. Second, not only has the range, distribution and availability of food for the mass of the people been dramatically changed, but there is abundant evidence that this has materially improved the physical condition of the community as a whole. Third, the food industry may be justly proud of the part they have played in these developments. Fourth, the development of the food industry is based on the application of scientific research, and the full support of the industry for research is necessary for its continued progress and prosperity. Fifth, this research must be both fundamental and applied; your Research Association is well placed to maintain the proper balance. Sixth, to do this effectively fuller encouragement and support for the Research Association from every part of the food industry and related industries is necessary. Seventh, everything should be done to make the liaison between science and the food industry as effective and fruitful as possible to all concerned.

News from the British Association of Chemists

SERVICES TO MEMBERS

The following extracts from letters from members speak for themselves:

Legal Aid

. . . the firm by whom I was engaged as Chief Chemist and Works Manager, underwent a reorganization, due to the passing on of its managing director. From the newly born directorate I obtained a five-year agreement and foolishly enough signed it without first submitting it to head office for the General Secretary's ever ready and willing comments.

'About seven months later, I was served with "notice" terminating my services with the firm on the slenderest excuse. Notification of my plight was immediately sent to Empire House and my eyes were gently yet effectively opened to the fact that apart from the illegality of my dismissal, I should never have penned my signature to such a one-sided contract.

'Within three weeks, after a meeting of creditors had been called, it was decided to put the company into voluntary liquidation and the chances of my securing any monetary satisfaction seemed, to say the least of it, remote.

'After a somewhat protracted period, which was nevertheless interesting and an education to the legally uninitiated like myself, the Liquidator who had been appointed began negotiations for a settlement. As the firm and its Liquidator were situate in the provinces, my case was referred to the local agents of the B.A.C. Legal Department, with whom I had several most cordial and reassuring interviews.

'Eventually a settlement was agreed upon, without my having even to meet any of the opposing side, or engage in the unpleasant task of appearing before an arbitrator.

'My name as a chemist was cleared. A cash settlement has been agreed upon and has been partially paid; the agreement was nullified, and I have been presented with a testimonial acknowledging my work for the Company.

'When I obtain a fresh appointment, it will be my desire to put into practice the lessons I have learned from the B.A.C. Legal Aid Department, of vigour, human understanding and efficiency, so that my usefulness as a servant to my future employers may be appreciated, and so my ability to help this protecting organization will be assured.'

Thanks for Guidance

'I should like to take this opportunity of tendering my warmest thanks to you and your efficient staff for the way in which you have assisted me to change over my position to an improved one with better security of tenure. At a certain point in the negotiations, unless I had been guided correctly, I might well have lost three months salary, as well as jeopardized my standing with the new firm. I should like you to publish this letter so that young chemists may realize the importance of correct guidance at the right time, from people experienced in negotiations, to the advantage of the member concerned.

'The value of such a service is inestimable when one considers that a false step in the early part of taking up a new post may well affect one's career for long periods in the future.

'I enclose a cheque as a small token of my gratitude.'

News from the Sections

Notts. & Derby

The Annual Meeting of the Section was held at the Moon Hotel, Spondon, on the evening of Tuesday, May 26, 1959.

The following Officers were elected for 1959/60:

Chairman:	E. Stonehouse
Vice-Chairman:	R. S. Locke
Hon. Secretary:	A. L. Kennedy
Hon. Treasurer:	A. J. Wesson
Committee:	H. Bates E. S. Desborough L. H. Jehue J. F. Neilson F. Hindley J. Hawkes W. J. Threadkell
Section Councillors:	A. J. Wesson E. Stonehouse

On the conclusion of the ordinary business of the meeting the General Secretary of the B.A.C., who was present, gave members a résumé of the work of the Association during the past year and answered various questions put by them.

The Hon. Secretary reported on the work of the Section Committee during 1958/59 and mentioned also that during the past two years the Hon. Secretary of the B.A.C. Notts. & Derby Section had acted as Secretary of the East Midlands Joint Chemists Council and had been responsible for editing the calendar of scientific meetings in the East Midlands. This function now passes in rotation to the other participating societies.

UNIONIZATION OF UNITED STATES SCIENTISTS

The interest by the AFL-CIO in organizing scientists and engineers is causing considerable interest and comment. Walter J. Murphy, editor of *Chemical and Engineering News*, devotes the complete editorial of February 23 to the subject. Mr. Murphy tends not to favour the trends towards unionization, although he recognizes that there are many point sin its favour. He criticizes the universities for not giving students a strong sense of professionalism, and comments unfavourably on those which seem to turn out robots of science and engineering without accepting responsibilities which go with belonging to a learned profession.

Mr. Murphy quotes the characteristic error of assuming by implication, that membership of unions, and the acceptance of unions as negotiating bodies, implies some form of regimentation or levelling. He admits, however, that many believe that union membership is not incompatible with creativity and recognition of the truly competent.

Conditions in the U.S.A. may be somewhat different from those in this country in some respects, but they are identical in the fact that the chemist strives to obtain professional status, and as an employee, feels the need for a protecting organization. The correspondence columns of *Industrial and Engineering News* have a familiar ring. Writers call for a better effort to make use of the abilities of science and engineers. One correspondent criticizes the U.S. Government for 'not understanding or appreciating those who devote their lives to the advancement of science and technology.' He criticizes the self-interest and political acumen of uneducated, unappreciative laymen, and comments on salary levels, degree of responsibility, interdepartmental wrangling, lack of policy, and a loose conception of security requirements as matters for investigation.

All correspondence and enquiries concerning this Association should be addressed to G. R. Langdale, Esq., The British Association of Chemists, Nomination Dept., 14 Harley Street, London, W.1. Tel.: Museum 7021.

Laboratory Note-Book

D.S.I.R. Technical Digests—which proved so popular among industry during an experimental try-out two years ago—will return to the field of available literature in the next few weeks.

Over three hundred technical periodicals are published in this country—usually weekly, monthly or quarterly. They describe a vast number of novel ideas and new techniques. But only the largest organizations, with their own information services and libraries, are able to digest everything of potential value. The average industrial firm probably limits its reading to a small number of journals concerned with its special field of interest. It may miss developments in a different field which could be applied to its own problems.

D.S.I.R. devotes considerable effort to helping industry—especially the smaller units—to bridge gaps in scientific 'know-how'. The Technical Digests should be valuable in pin-pointing new ideas and —at least as important—the sources of information about them.

The Technical Digests will be published monthly as a small compendium of ideas, each presented on a separate sheet of paper. This method of individual treatment should prove popular with industrial users, as items of interest can so easily be passed to the most appropriate quarter without loss of time by general circulation.

The annual subscription is £3. 3s. 0d. for sets of 15 items per month. To encourage large firms to distribute Digests among their staff, a reduction will be offered for quantity supplies.

Britain's Future

'Britain's future in the next decades will be decided in her laboratories and workshops and not on the playing fields of Eton', says the Association of Scientific Workers in a new booklet 'The Rate for the Job', which examines the existing wages of scientists and strongly recommends that they should get a 'rise'.

The A. Sc. W. proposals are designed, according to the booklet, 'to redress to some extent, the gross under-payment which is widespread in industry and in many fields of public employment, and to provide an incentive for young people to enter upon a scientific career.'

The booklet complains that young people are not rushing forward to embark on a technical career and that many parents are disinclined to make the financial sacrifices to enable their children to qualify as scientists and engineers mainly because of the inadequate regard which our society has for scientific workers and the poor career prospects open to them compared with other professions.

The 'Rate for the Job' also examines the impact on Britain's economic and social development, Britain's need for more scientists and the shortage of scientists. It discusses whether trade unionism can advance the professional status of scientists and quite obviously believes that it can. Finally the booklet gives recommended minimum salary scales for all branches and grades. The Association is concerned with the whole field, from junior laboratory assistants to a senior professor in charge of a major scientific undertaking.

The booklet makes out a clear case in support of the claim that earnings of scientific workers are inadequate.

A qualified engineer who before the war might expect his salary to rise to £600 should today earn about £2,300 to maintain his position in the light of increases in the cost of living and direct taxation and to share evenly the 7 per cent increase in consumption per head which has occurred since 1958. In actual fact and in a job of some responsibility he can probably expect to receive £1,000 to £1,500, reports the booklet.

By the same reasoning the Association concludes that a fully qualified scientist or technologist should be earning some £2,000 a year by the age of 35, a man with less, but still significant qualificatons £1,500 and a trained assistant £1,000.

D.S.I.R. Annual Report 1958

The Report of the Council for Scientific and Industrial Research for 1958 was published on May 6.

At a press conference, Sir Harry Jephcott, Chairman of the Research Council, said that in their second year of office—the period under review—they were taking action on what they had found out as a result of a thorough survey of many aspects of the Department's work.

'We have reached a much clearer picture of the way in which the Department should go. One of the main things we discovered was that the amount of money spent on research at Universities was not adequate, and we decided to increase our grants for special researches. The amount has already been increased and by the end of the second five-year plan there will be a really worthwhile effort.'

The most interesting aspect of the Report was the planning for the second five-year plan. D.S.I.R. was exceptionally fortunate in being permitted to budget for a five year period. It was a very valuable arrangement and almost essential to Council's task. Sir Harry emphasized, however, that they were keeping the plan flexible.

He recalled that last year Council had said that the research effort must be increased and the Department had a large part to play. 'You will notice that the Government has acted on this recommendation of ours', he said. 'Whereas the Department received £36 million over the last five-year plan, we shall receive £61 million over the second five-year plan. This is a handsome increase, although, of course, one can never be satisfied where research is concerned.'

Dealing with Council's proposal to support valuable research and development ideas in industry, Sir Harry said: 'This is an entirely new idea for the Department. It is in the early stages and I can say little about it at the moment—but we think that this may turn out to be one of the most valuable and exciting of our new ideas.'

He then dealt with criticisms of the Research Associations. When the Research Council said that they would report on the Research Association movement this was assumed in some quarters to imply that the Council thought that things were seriously wrong with the movement. The Industrial Grants Committee had now carried out an extensive investigation of the movement and of its value to the country as a whole. 'I will leave you to read the report,' said Sir Harry, 'so that you can realize the strength of our feeling that the Research Association movement is of very great value to the country as a whole and to the particular industries with which it deals.'

Alexander Popov Gold Medal

THE Royal Society has been informed that Dr. Louis Essen, a Senior Principal Scientific Officer at the National Physical Laboratory, has been awarded the A. S. Popov's Gold Medal by the Academy of Sciences of the U.S.S.R. This award is for the most distinguished scientific work in the field of radio-engineering performed during the period from 1956 to 1958. The work of scientists from all countries is considered, but this is the first time that it has been awarded to a scientist outside the Soviet Union.

The outstanding achievement which has won Dr. Essen this recognition has been his work leading to the establishment of an atomic frequency standard as a possible basis for the future standard of time which would have greater precision and be more easily accessible than the astronomical standard for the purposes of radio-engineering and physics. Dr. Essen has also played a leading part in establishing that the precision of the caesium standard and the stability of propagation of low frequency radio waves meet the demands of improved aerial navigation systems which require times and frequencies to be compared over very long distances with great accuracies.

The importance of this work was recently recognized by the presentation to Dr. Essen of the first Wolfe Award, given to the research worker considered by the Department of Scientific and Industrial Research to have made an outstanding contribution to the research work of the Department during 1958.

LABORATORY EQUIPMENT & APPLIANCES

Flow Inducer

The W-M H.R. flow inducer can be applied to the transference of virtually any fluid, liquid, emulsion, slurry, cream or gas, without modification other than its incorporation in a suitable pipe, which must be provided anyway.

It will pump slurries containing, for example, aluminium hydroxide, so stiff that they will hardly find their own level in a vessel, as readily as a corrosive gas, for example, chlorine, the special Fluon-sleeved pipe being inert to all chemicals, acids, alkalis and solvents, whatever their pH, with the exception of molten sodium and some flourine compounds at high temperatures.

It can be used to generate and hold considerable vacuum and it will act as an oil-free air compressor.

There is no cleaning problem at all—either water can be pumped through after a run or, for rapid change from one duty to another, without the possibility of contamination, a pipe kept for each fluid can be inserted in a minute.

There are no glands so leakages and aeration through them are eliminated.

There are no non-return valves or mechanisms of any kind in the path of the fluid and hence nothing to jam or corrode. Yet flow can only take place in the desired direction.

All mechanical parts are designed to be self-lubricating—the W-M H.R. flow inducer requires no maintenance and no technical knowledge to operate. It is extremely compact and self-contained—as suitable for the laboratory bench as the shop floor.

Delivery per revolution of the rotor is virtually constant so that it can be used for dosing and metering operations. A pre-set revolution counter with automatic cut-out can be incorporated if required.

The fluid is not subjected to shear in transference—an important consideration in handling emulsions.

The unit is self-priming even when dry—and can be run dry.

(Manufacturers: The Laboratory Glassblowers Co., Valley Works, Lane End Road, Sands, High Wycombe, Bucks.)

The W-M H.R. flow inducer.

B.T.L. 'Bara' Wide Range Incubator

The B.T.L. 'Bara' wide range incubator, of all-metal construction, is a logical development from the previous models listed in the B.T.L. range. The new model is of the water jacketed type and is capable of direct operation at temperatures up to 80°C. It can also be operated at temperatures below ambient by passing external cooling water through the jacket.

Typical temperature variations at one point in the chamber are ± 0·4°C. at 37°C. and ± 0·2°C. at 56°C., while the maximum temperature differential between two points in the chamber is 1·5°C. at 37°C. and 3·0°C. at 56°C. Temperature control is effected by a B.T.L. bimetallic regulator operating through a Sunvic relay, reproducibility at a fixed setting being ± 0·5°C. Accurate temperature setting is achieved by means of a control knob with an arbitrary illuminated scale of 0-100 having an effective length of 10 in., used in conjunction with a separate calibration table supplied with each incubator.

The B.T.L. 'Bara' wide range incubator is of the water jacketed type and is capable of direct operation at temperatures up to 80°C.

The control panel, which carries mains and heater pilot lights and the illuminated regulator scale, is recessed into the sheet metal case of the incubator beside the door, and has a removable Perspex cover to protect it from casual interference. Above the control panel is a recessed illuminated thermometer reading 0°-100°C. in 0·5°C., which allows a check to be kept on the chamber temperature. The tinned copper chamber, 20½ in. × wide 17 in. deep × 27 in. high, is fitted with runners so that the three shelves provided with each incubator can be used in any three of six possible positions. An inner door of ¼ in. toughened plate glass with a magnetic latch protects the chamber. The chamber jacket allows the circulation of water around the top, bottom, sides and back of the chamber, giving extremely even heating, and the inlet and outlet water tubes are of carefully proportioned sizes to eliminate overflowing. The top of the incubator is fitted with a water level indicator, a breather tube for the jacket, and a tubulure which allows a second thermometer, thermocouple or other device, such as a stirrer, to be inserted into the chamber.

The incubator is finished externally in ivory stoved enamel, and has an overall size of 34½ in. wide × 24½ in. deep × 38½ in. high. It weighs 216 lb. empty and 316 lb. when operational, the capacity of the jacket being about 10 gallons. The incubator is fitted with a 6 ft. lead with open ends and can be supplied for operation on 100/115 V. or 200/250 V., A.C. only, with a mean consumption of 100 watts at 37°C. and 160 watts at 56°C. (Manufacturers: Baird & Tatlock (London) Ltd., Chadwell Heath, Essex.)

NEWS

Manufacturers' News

Displays of B.T.L. Equipment in Belgium

During the VIIth Colloquium on the Proteids of Biological Fluids, held at Sint Jans Hospital, Bruges, from May 1 to 3, 1959, Baird & Tatlock (London) Ltd. showed a selection from their new range of equipment for chromatography and electrophoresis at the Apparatus Exhibition in the Bruges Concert Hall.

The Colloquium was attended by delegates from all West European countries, from Canada and the U.S.A., and from behind the Iron Curtain.

The equipment was demonstrated by Mr. C. E. Fox of the B.T.L. Research and Development Division; he was assisted throughout the Exhibition by Mr. Zecchini of Armand Dutry & Co. Ltd., who are agents in Belgium for Baird & Tatlock (London) Ltd.

The following equipment was shown at the Bruges Colloquium:

1. *B.T.L. Fraction Collector:* a fraction collector of ingenious design which delivers accurately measured and clean-cut fractions into a continuous belt of test-tubes held together by stainless steel links, thus combining large capacity with ease of handling of fraction groups.

2. *B.T.L. Chromatographic Desalting Apparatus:* a simple, compact and inexpensive electrolytic desalter employing ion-exchange membranes to remove inorganic salts which would otherwise interfere with chromatographic separation. Developed from the instrument described by J. D. Blainey and H. J. Yardley in 'Nature', January 14, 1956, p. 83.

3. *B.T.L. Equipment for Electrophoresis:* comprising three items: the *horizontal tank*, moulded in one piece in heat-resistant opal glass, for separations on paper, starches and gels, or for immuno-electrophoresis: the *constant current/constant voltage stabilized power unit*, a high-grade electronic unit, combining the facilities normally requiring two separate power packs, at a competitive price; and the *densitometer*, a semi-automatic instrument for the rapid and convenient evaluation of stained paper strips by transmitted light, which can be made fully automatic by connecting to a chart recorder.

British Trade Fair, Lisbon

A representative selection of their latest instruments including the Pye Argon chromatograph was shown by W. G. Pye & Co., Ltd., at the British Trade Fair, Lisbon.

Other instruments on view were pH meters, measuring microscopes, precision potentiometers, bridges, 'Scalamp' galvanometers, test sets, and D.C. amplifiers and microvoltmeters.

Stopcocks and Interchangeable Keys

G. Springham & Co., of Harlow New Town, Essex, sole manufacturers of the Interkey range of products, are now marketing these with a 3 and 4 mm. bore key size. This incorporates all separating funnels from 250 cc. to 1,000 cc. inclusive and an abridged price list is available on request from the manufacturers.

Personal Notes

Mr. S. H. Elliott's Tour

Mr. S. H. Elliott, Managing Director of H. J. Elliott Ltd., has recently completed an extended tour of Denmark, Sweden, Norway and Finland, to visit stockists and distributors of the E-MIL brand of volumetric laboratory glassware, thermometers and hydrometers, followed by a flying business visit to France.

Dr. Robert T. Parker

Dr. Robert T. Parker has been appointed head of Aluminium Laboratories Ltd., Banbury and Geneva offices in succession to Mr. R. D. Hamer.

Dr. Parker, an Associate of the Royal School of Mines, joined the Aluminium Limited Group in 1938 and transferred to Aluminium Laboratories Limited in 1946 as Head of the Metallurgical Division. In 1950 he became Director of Research at the Banbury laboratories. He had previously been engaged in research with the British Non-Ferrous Metals Research Association. Dr. Parker is a fellow of the Institution of Metallurgists and Fellow of the Royal Institute of Chemistry. For a number of years he has been chairman of the Aluminium and Magnesium Industry Committee of the B.N.F.M.R.A. and chairman of the Aluminium Development Association Research Committee, serving also on the Institute of Metals Publication Committee, B.N.F.M.R.A. Research Board and a number of Government Metallurgical committees. He is a past-chairman of the Oxford Local Section of the Institute of Metals.

Publications

Scientific and Technical Conferences

The Department of Scientific and Industrial Research Overseas Liaison Division, has now issued an addendum to List No. 24, Forthcoming International Scientific and Technical Conferences.

CATALOGUES, BROCHURES & LEAFLETS

Received from Manufacturers

B.D.H. Leaflets.—New entries in the catalogue of British Drug Houses Ltd., Poole, Dorset, are listed in the May 1959 issue of their monthly leaflet. These are as follows: *Organic and Inorganic Chemicals.*—*n*-Dodecylamine; sodium dehydro-acetate; stannic sulphide, and thymolphthalein complexone.

Thermometers.—The catalogue published by J. McKenzie & Son of 40 Rosoman Street, London, E.C.1., contains details of the wide range of patterns manufactured by the company. Facilities for producing all classes of special thermometers, glass apparatus, metal components, etc., not listed in the catalogue are also available and the company are pleased to quote for such specialized needs on submission of a blueprint, rough sketch or similar specification.

Nitrogen Generators.—The Dryer and Gas Plant Division of Birlec Ltd., Erdington, Birmingham 24, have recently issued a catalogue giving details of the newly developed range of Birlec nitrogen generators.

Hilger Journal.—The February 1959 issue of the Hilger Journal (Vol. V, No. 3) published by Hilger & Watts Ltd., of 98 St. Pancras Way, Camden Town, London, N.W.1. contains articles on spectroscopy and an automatic motor drive for plate racking on a Hilger Littrow spectrograph, together with items of news and abstracts from recent papers.

Electronic Recorder.—List 186 and Supplement 'A' published by the Cambridge Instrument Co., Ltd., 13 Grosvenor Place, London, S.W.1. are devoted to the Model DE electronic recorder, a high-performance instrument of proven reliability with a full scale response speed of better than two seconds, a minimum range of 1 mV., a sensitivity of better than 1 μV., and an overall accuracy of better than ± 5 μV. It forms an integral part of the company's complete equipment for the measurement of temperature, gas concentration, pH, conductivity of solutions, dissolved oxygen in feed water, strip width and thickness, radiation intensity, etc., and can be supplied for numerous other applications in industry and science.

Hydrometers.—J. W. Towers & Co. Ltd., of Victoria House, Widnes, have issued a new hydrometer catalogue, No. 709, which includes details of the full range manufactured by the company. Price reductions are in force for many of the patterns shown.

He's out to prove something

Most of us, in our formative years had decided views that this gentleman never really deserved laurel leaves. However, he reached some very sound conclusions. We have a few theories also, about the installation and equipping of laboratories. If this is one of *your* problems, we may be able to help in getting that quart into a pint pot

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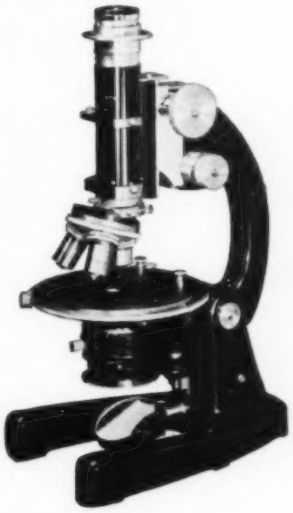

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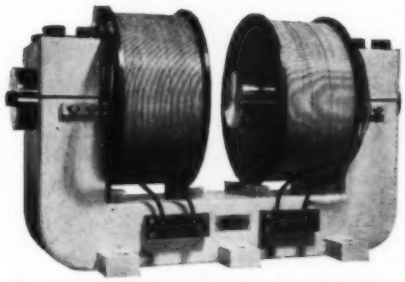

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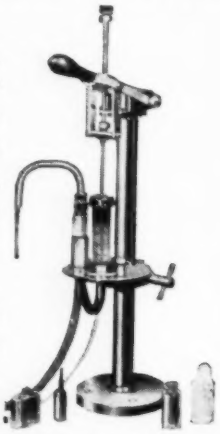

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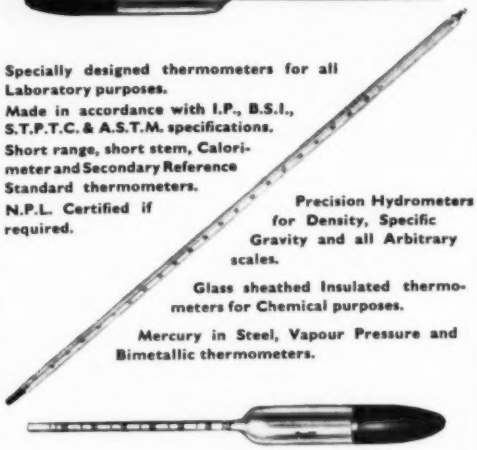

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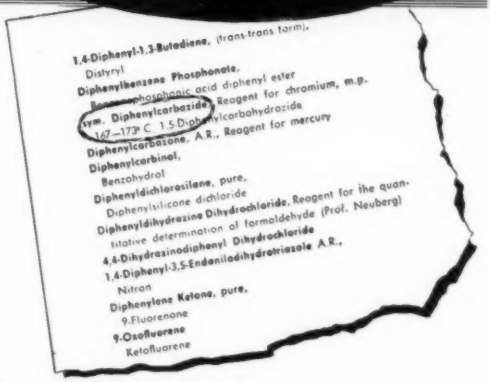

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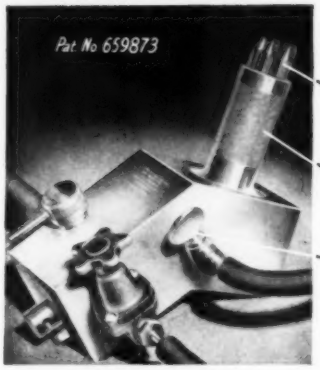

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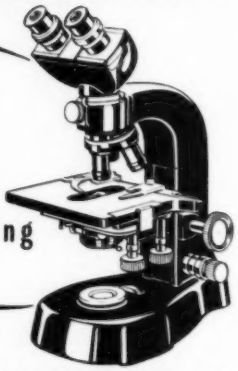

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Index to Advertisers

Adelphi Manufacturing Co., Ltd. clx
Alexander, Herbert & Co., Ltd. clv
Anderman & Co., Ltd. .. .. .. June
Astell Laboratory Service Co., Ltd. cxlvi
Baird & Tatlock (London) Ltd. .. .. Cover i
Barcham Green, J., Ltd. clxiii
Beck, R. & J., Ltd. clxii
Beecroft & Partners, Ltd. cxlvi
British Drug Houses, Ltd., The cl
British Electric Resistance Co., Ltd. .. .. .. June
Camlab. Ltd. cliii
Classified Advertisements clxiv
Cooke, Troughton & Simms, Ltd. .. .. .. June
Cuthbert, Ralph, Ltd. cxlviii
Davey & Moore, Ltd. cl
Davis & Thompson, Ltd. .. .. .. Cover iii
Difco Laboratories, Inc. .. .. .. Cover iv
Distillers Company Ltd., The cliii
Electrochemical Laboratories .. .. June
Electrothermal Engineering, Ltd. .. .. .. June
Elliott, H. J., Ltd. .. .. June
Endecotts (Filters), Ltd. .. .. June
Engelhard Industries, Ltd. .. .. May
Esco (Rubber), Ltd. clxiii
Evans Medical Supplies, Ltd. clvi
G.W.S., Ltd. .. .. May
Gallenkamp, A. & Co., Ltd. .. .. .. Cover ii
Gerrard, T. & Co., Ltd. clxi
Griffin & George, Ltd. clvii
Gurr Edward, Ltd. clxiii
Hawksley & Sons, Ltd. clviii
Hearson, Charles & Co., Ltd. cli
Hopkin & Williams, Ltd. .. .. May
International Combustion Products, Ltd. .. .. June
Isopad, Ltd. .. .. June
Jacobson Van Den Berg & Co. (U.K.), Ltd. .. clx
Jencons (Scientific), Ltd. .. .. May
Jobling, James, A. & Co., Ltd. .. .. .. June
Jones, Samuel & Co., Ltd. clxii
Laboratory Glassblowers Co., Ltd. clv
Light, L. & Co., Ltd. .. .. June
London Office Machines, Ltd. cxlix
Loughborough Glass Co., Ltd. cxliii
Manesty Machines, Ltd. clii
May & Baker, Ltd. cxlviii
Measuring & Scientific Equipment, Ltd. cliii
E. Merck, AG. .. .. June
Morbank, Ltd. cliv
Newport Instruments (Scientific & Mobile), Ltd. .. clix
Oxford University Press .. .. May
Oxo Ltd. (Medical Dept.) cxlvii
Parvalux, Ltd. .. .. June
Pascall Engineering Co., Ltd., The .. .. cliv, clx
Permutit Co., Ltd., The .. .. June
Savage & Parsons, Ltd. .. .. June
Scorah, L. V. D., M.Sc. clxi
Shandon Scientific Co., Ltd., The cliv
Siemens Edison Swan, Ltd. cxliv
Short & Mason, Ltd. .. .. June
Spencer Components .. .. June
Springham, G. & Co. clviii
Stabilag Co., Ltd., The clviii
Stanton Instruments .. .. June
Sunvic Controls Ltd. .. .. March
Swift, James & Son, Ltd. clix
Taylor Rustless Fittings Co., Ltd. clxii
Thermal Syndicate, Ltd., The cxlv
Tintometer, Ltd. .. .. May
Towers, J. W. & Co., Ltd. cli
Watson, W. & Sons, Ltd. clxi
Wild-Barfield Electric Furnaces, Ltd. .. .. June
Zeal, G. H., Ltd. clx

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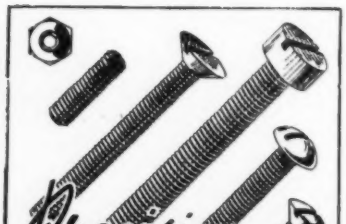

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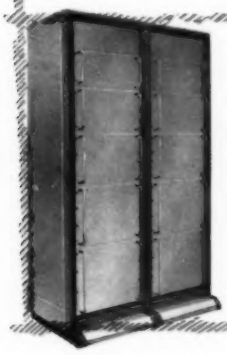

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